Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LX APRIL, 1921 No. 4

CONTENTS

EDITORIALS 133, 134

LEADING ARTICLES

Special Features of Imhoff Tank Construction 135
Letting Grading and Bridge Contracts on Illinois State Bond Issue Roads 140
Analyses and Preparation of Highway Cost Estimates 144
The Relation Between the Flood Flow of Streams and Intensity of Rainfall 147
Contract Forms 150
The Trend of Engineering Specialization 154

WATER WORKS SECTION

San Francisco's Failure to Acquire the Spring Valley Water Works 157
Impounded Water at Bloomington, Ind. 159
Water Purification at Whiting, Indiana 161
Personal Items 164
Operating a Water Works Plant Under State Supervision 164

CONSTRUCTION NEWS AND EQUIPMENT

Equipment Employed on Road Construction in Minnesota in 1920 23
Houston Construction Co. Paves 109 Ft. Per Hour 24
The Use of Tractors on Road Construction and Maintenance Work 26

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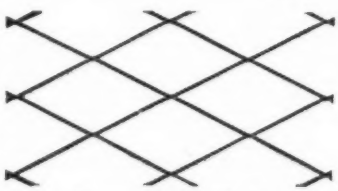
Reinforcing Steel Saves Expense on Concrete Roads



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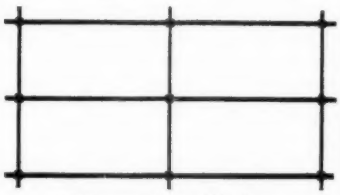

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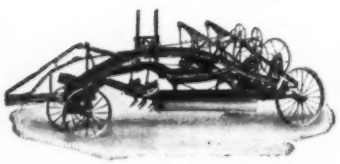

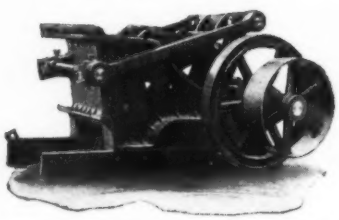

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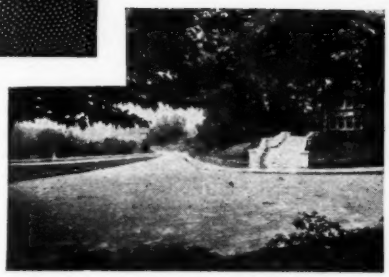

TEXACO Asphaltic Concrete in the famous Grove Park Section of Asheville, N. C. This pavement was built in 1917 on old macadam.

To combine beauty with durability. That was the paving problem in Asheville, N. C., America's famous resort. This problem was solved successfully by laying TEXACO Asphaltic Concrete.

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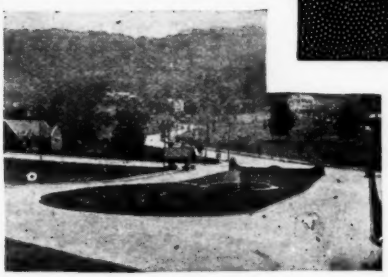

Another view of the TEXACO Asphaltic Concrete in Asheville, N. C., which was constructed in 1917.

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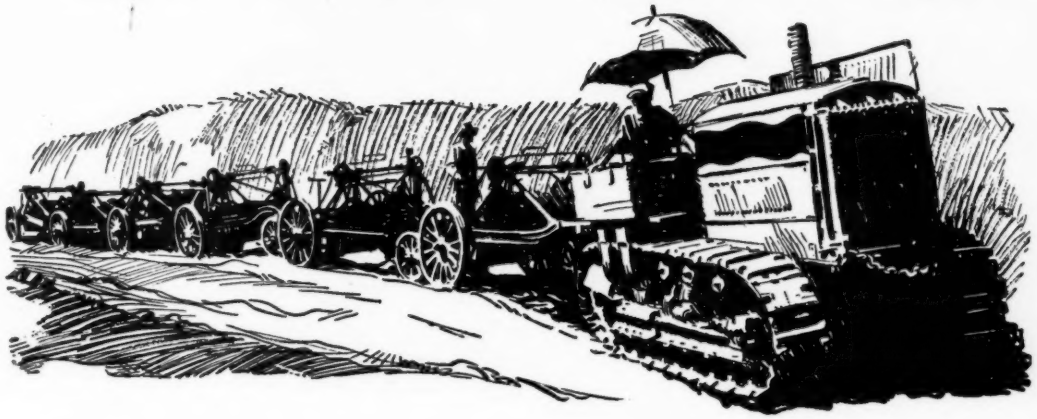

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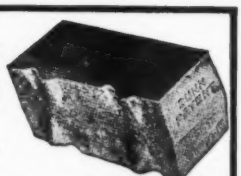

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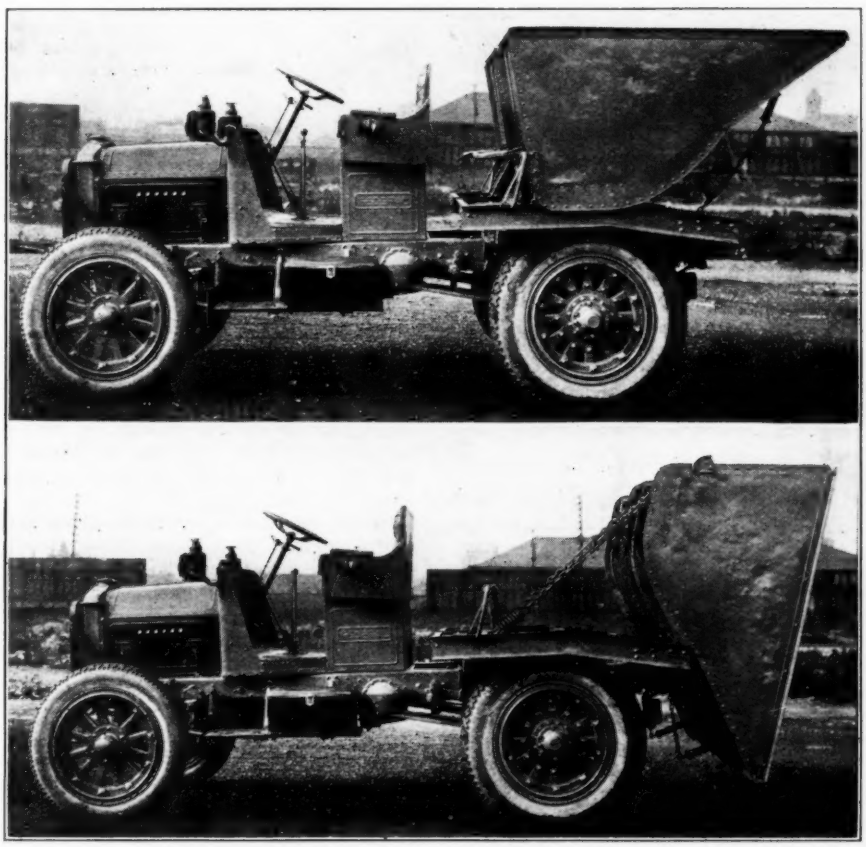
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



FEDERAL ROAD BUILDERS' TRUCK EQUIPPED WITH TWO BATCH LEE DUMP BODIES, IN RUNNING AND DUMPING POSITIONS.

Motor Truck Operation and Accounting LXVIII

Use of Trucks for Garbage Collection at South Pasadena, California.

The information here given on the use of motor trucks for garbage collection is from a letter to the editor by Mr. R. V. Orbison, City Manager of South Pasadena, California:

"The City of South Pasadena has a population of over 8,000, an area of 3½ sq. mi.; about 45 miles of traveled streets and approximately 2,500 residences.

"In the collection of garbage, the city was divided into three sections, and a twice-a-week collection is made from each district by the city. The business sections and the hotels receive a daily service.

"We are using a Bethlehem 1½-ton truck equipped with a 3-yd. dump body and a Woods hydraulic hoist. The crew consists of a driver and two pick-up men, and they average 20 miles of streets per day. As the garbage is kept in the rear of the premises, it necessitates the men walking farther, and consequently requires more time than where the garbage is placed on the parking. The pick-up men work very fast and it requires about six hours for each district.

"Based upon the past 8 months' records, the cost of collecting our garbage is as follows:

Salary	$2,840
Oil and gas	240
Tires	380
Repair	55
	$3,515
Less sale of garbage	1,073
	$2,442

Or $305 per month.

"This gives an average cost of 67c per truck mile, and 45c per capita per year.

"The truck driver has a key to the police boxes and calls in at different hours for complaint slips.

"There is no question in my mind but that the motor truck is indispensable in the collection of garbage. There are locations, however, where teams could be advantageously used by having a motor truck haul trailers to different sections of a city, collecting the garbage with the trailers drawn by teams and then collecting the loaded trailers with the truck."

Building Trucks to Meet Requirements

The strong truck companies do not manufacture trucks merely according to their own ideas of what the customer should want but spare no effort to learn just what the customer's requirements really are and then trucks are built to meet those requirements. Above the chassis there is room for great flexibility in design and in body design particularly the product of the truck manufacturer indicates how closely he keeps in touch with the changing and developing requirements of his customers in various lines of business.

To illustrate how a well-established truck manufacturing company goes about serving its clientele reference is here made to the practices of the Kissel Motor Car Co., Hartford, Wis., in rendering engineering service to road builders.

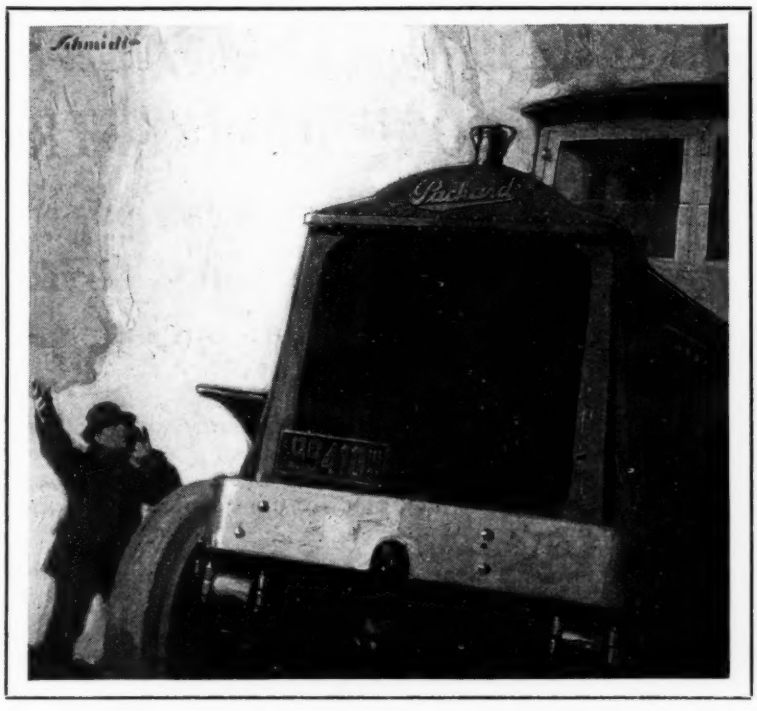
Kissel during the past 15 years has developed and perfected: First—proven types of motor truck hoist and dump equipments, dual hopper units, load spread regulators and other types of haulage units; Second—Kissel engineering service for contractors and road builders.

In designing and perfecting the Kissel "Heavy Duty Road Builder" with dump body and hydro hoist—the Kissel Dual Hopper Dump Body and other road construction units and equipment—Kissel employed knowledge gained by studying contractor's problems on the road—as well as with road builders and contractors who have visited the Kissel factories.

Kissel engineering service gives scientific attention to transportation requirements of contractors who are contemplating additional equipment, or who are planning additional investment in motor truck equipment. This service goes beyond truck building by building up profit for contractors—by supplying equipment that pays for itself in a short time.

The Kissel Motor Car Company's engineering division has for the past five years made a special study of the adaptability of the motor truck to good roads work. This study has not been superficial, nor has it been confined to one locality, but on the contrary the engineers'

PACKARD



Heavy Duty Packards Predominate

Fifteen years ago, the city of Detroit purchased its first Packard Truck. Today this same truck is working faithfully shoulder to shoulder with newer Packards built as late as 1921.

In the service of the city, and under the competitive conditions this service imposes, heavy duty Packards have demonstrated their power, economy, and steadfast stamina.

Already the municipality owns and operates 87 Packards. As their other trucks wore out or became too expensive to operate, Detroit replaced them with heavy duty Packards.

Packard Trucks consistently perform at low cost and with sure dependability. They are powerful and strong. They are expertly rated to the work required of them. They have the advantage of local service facilities established to maintain every Packard as a unit of high earning ability.

PACKARD MOTOR CAR COMPANY · DETROIT

Ask the man who owns one

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KISSEL

Designs and Develops a Highly Efficient

SPECIAL ROAD BUILDERS' TRUCK

To Meet the Requirements of

C. F. LYTLE, Sioux City, Iowa,

one of the largest contractors and building engineers in the country.

Mr. Lytle is building about 18 miles of 20-foot cement road, from 8 to 11 inches thick, with gutters, in Sioux City, Iowa. He needed a truck to speedily carry two batches—1¾ cubic yards each—of sand, gravel and cement from his supply base to the mixer—a truck that was not only **economical,** but one that was **thoroughly dependable.**

Mr. Lytle's complete fleet of tenKissel Special Road Builders' Trucks will be shown in the next issue of this publication.

General Specifications of Kissel's Special Road-Builders' Truck

Short wheelbase—special double channel frame for strength—36x6-inch front, 42x9-inch rear, Pneumatic Cord tires—special steel body with special center partition and gate to handle two batches—powerful motor—special sectional driver's cab—horizontal two-cylinder hoist—tire pump—the whole job geared and powered for flexibility, power and proper speed.

In deciding on Kissel Trucks and his source of supply for transportation units, Mr. Lytle necessarily took into consideration not only truck specifications, but the reputation and fifteen years' experience of the Kissel Motor Car Company, as truck builders and transportation engineers, and their ability to give efficient service at all times.

Kissel's ability to produce motor truck equipment to meet contractors' specific requirements is due to thorough study of road builders' problems, coupled with an engineering service based on analyzing contractors' transportation needs and determining the proper equipment to solve them.

Literature describing Kissel Equipment in the service of prominent Contractors and County Commissioners sent on request.

KISSEL MOTOR CAR CO., Hartford, Wis.

SPEED—ECONOMY—DEPENDABILITY

KISSEL

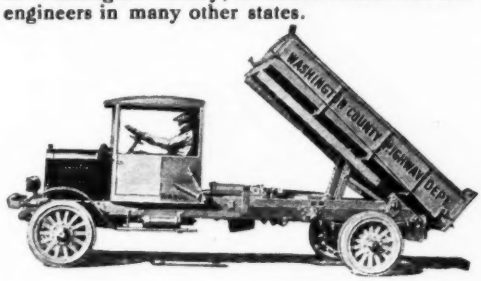
DUAL HOPPER DUMP UNIT

KISSEL Engineering Service to contractors comprises designing and building transportation units to fit particular requirements or individual needs, depending on type of work.

The above Kissel Dual Hopper Dump Unit is an example of a Kissel Unit supplied to a contractor who required special equipment to fit a specific purpose.

Result—this Kissel Dual Hopper Dump Unit, built with 116-inch wheelbase, eliminates rehandling of material by hauling direct to the mixer.

Kissel Heavy Duty Road Builder shown below, is a Kissel Engineered Unit, designed and built for heavy work in gravel road building for the Wisconsin Highway Commission in Washington County, as well as contractors and engineers in many other states.



THE HUG TURN TABLE, used in connection with concrete road work, turns the truck in a very short radius, to the mixer, without injuring the cross bed or disturbing the cross boards.

Further details regarding Kissel Engineering Service to Contractors, and road building equipment, can be had by addressing

KISSEL MOTOR CAR CO.
HARTFORD, WIS.

SPEED—ECONOMY—DEPENDABILITY

analyses have been from the ground up, taking in every grade of soil encountered in all parts of the United States.

The haulage, mixing and spreading of different kinds of road buuilding material—the obstacles road builders are constantly up against—all have been analyzed, studied and classified, and the 1921 Kissel road building equipment for gravel as well as for concrete work, ranging from the Dual Hopper job the Kissel Heavy Duty Road Building Truck, with exelusive body, loading and unloading equipment, is the result.

The Kissel Contractors and Good Roads Division

The increased demand for the Kissel "Heavy Duty" model, popularly known as the Kissel Road Builder, necessitated the formation at the Kissel factory of the Contractors' Division, formed for the express purpose of giving individual study to the peculiar haulage problems of contractors and county commissioners.

This division is composed of not only the Kissel Transportation Engineers, but the regular Kissel engineering corps, augmented by the Kissel Zone Distributors. It works with contractors and county commissioners who are either contemplating additional equipment or who are planning initial investments in motor truck equipment.

As an example of how this Contractors' Division works, the following excerpts from a plan sent to a western contractor are interesting:

"Regarding the cost and performance of Kissel Trucks on your 5½-mile job with three mixing stations:

"This job figures approximately 10,500 cu. yds. mixed material. The daily capacity of your mixer is 300 cu. yds. maximum, which, under ideal conditions, would mix the job in 35 days' time, barring delays for weather and breakdowns.

"The maximum hauling distance from any one mixing point is about 1 mile. Therefore, with the mixing time for 1 batch being 1 minute, a 1½ cu. yd. load would require 5 minutes' time. The speed of truck 12 miles per hour would require 15 minutes for a round trip. On this basis 4 trucks of 1½ cu. yd. capacity would be required to keep the mixer going steadily."

Then followed a table, listing the approximate cost of the Kissel truck equipment necessary to handle the foregoing job.

This cost table was made up of the price of the chassis, the dump body and hoist equipment and freight charges to destination. The sum total of these three items made up the initial truck investment, to which were added the following items:

1—Fixed Charges—which consisted of interest at 6%, depreciation for 5 years, taxes, license and insurance.

2—Maintenance Charges—consisting of such items as overhauling and repairing for the year, together with garage charges—the sum total representing the maintenance charges.

3—The Operating Charges consisted of estimated gasoline consumption for 310 days per year, lubricating oil consumption, wages of the driver and complete tire equipment for the full period. The sum total of these items represented the operating charges for the year.

The grand total of these initial investments—fixed charges, maintenance charges and operating charges—divided by the number of days the truck would operate each year, gave an operating cost of approximately $12 per day.

The plan then concluded with the following paragraph:

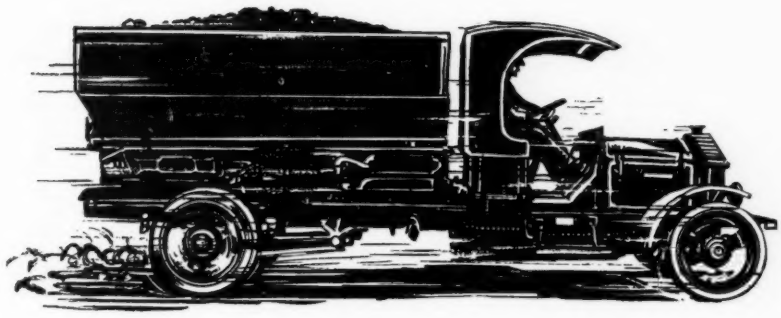
"The Kissel 'Freighter' should make a round trip on this job in 15 minutes, including loading time, and carry a 1½ cu. yd. load. At a cost of $12 per day, this will give you a unit cost of practically 15c per cu. yd. of concrete placed on the job by truck. Operation of four trucks for 35 days at $12 per day, the total cost of hauling the mixed concrete would be $1680."

Grading Contractor Changes from Horses to Trucks

The Carlin Grading Co., of San Francisco, have this to say in reference to their changing over from the use of horse-drawn to motor equipment on their grading work.

"For a great many years we operated entirely with horse-drawn equipment firmly believing that such equipment was essential to successful grading operation and in fact it was not without a struggle that we were finally convinced that motor equipment was necessary if we were to remain in business and successfully meet competition.

"We have had occasion at different times to rent trucks and a careful checking of their cost and efficiency as against our own horse-drawn equipment figured on a yardage basis finally convinced us. In September, 1919, we placed an order for two 5-ton Sterling chain driven, dual gear ratio dump trucks and operated them for three months under a careful cost system with the result that we immediately purchased three more and are now oper-



Speed and hill climbing

The present Pierce-Arrows travel from point to point 15% faster than before. Their hill-climbing ability —pulling out of holes or through sand—is 25% greater because of the Dual Valve Engines in them.

Governed to an indicated speed, their greater power permits them to maintain their pace, so they make more trips and cover a wider radius each working day.

Pierce Arrow

CHASSIS PRICES

2-ton $3750
3½-ton 4950
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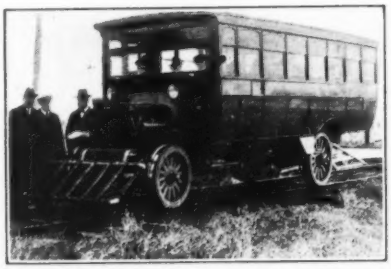
All Prices F.O.B. Buffalo

THE PIERCE-ARROW MOTOR CAR COMPANY, BUFFALO, N. Y.

ating a fleet of five Sterling dump trucks, and have recently placed an order for three more. We are selling off all of our horses and wagon equipment, and will in the future handle all of our operations with motor equipment. In fact at the present time we are using in addition to our own trucks 18 hired trucks of various makes."

Truck Runs on a Steam Rail Road

The Winchester & Western Railroad has recently installed a passenger service which is unique, and it is predicted that it may revolutionize the passenger service on short line railroads.



SERVICE 2½-TON TRUCK, EQUIPPED TO CARRY 34 PASSENGERS, AS OPERATED ON THE WINCHESTER & WESTERN RAILROAD.

This railroad is now operating from Winchester, Va., to Wardensville, West Virginia. The car is a powerful gasoline motor truck. It is equipped with a body which seats 34 passengers comfortably, is well heated and electrically lighted.

This body is mounted on a 2½-ton Service motor truck. The wheels are the same as on regular Service trucks, but instead of rubber tires flanged iron tires are used, which are the same as those used for the pony truck wheels of the largest locomotives. The rims are about 1 in. thick.

The truck runs on schedule time, and is hauling almost capacity loads. It arrives at Winchester at 9:55 a. m. and leaves at 3:00 p. m. Passengers are enthusiastic over the new car, and prefer it to a regular passenger coach; there is no smoke, dust, or cinders, and but very little noise.

The Winchester & Western Railroad has already announced "theater special" runs for the truck every Wednesday and Saturday evening, and the car will be available for special trips to town on any special occasion which may warrant it.

Pierce-Arrow Bus Makes 2,000-Mile Trip Through Eastern Cities

To demonstrate the strides made in the development of the modern motor bus, a 2,000-mile tour of eastern cities is being made by a bus recently introduced by the Pierce-Arrow Motor Car Company. The bus. which seats 25 passengers and incorporates all the latest safety and comfort devices, is designed especially for the dual-valve two-ton chassis, which permits of a safe and economical speed of 23 miles an hour with a maximum of comfort for the passengers.

With the adoption of motor busses by a number of street railway systems as a means of augmenting their regular equipment, the public is taking an interest in the growth in usage of this type of passenger-carrying vehicle. The appearance of the Pierce-Arrow, therefore, is attracting widespread attention in the various cities through which it is passing on its tour.

"Traction authorities today regard the motor bus as a valuable ally," says Robert O. Patten, truck sales manager of the Pierce-Arrow company. "By running busses in streets paralleling street car lines, congestion in rush hours is avoided. Equally successful is their use in tapping newly developed sections, for it is a costly matter to acquire new streets cars, new trolley poles and wire, and new tracks at about $75,000 a mile. Then, too, the motor bus solves the problem of handling circus-day, ball-game and other unusual crowds.

"In cities where trolley companies have added motor busses to their equipment, experience has shown that the bus service is comparable in headway, speed, earnings and economy of operation to the trolley service."

The route being followed by the bus includes the following cities: Rochester, Syracuse, Utica and Albany, N. Y.; Springfield, Worcester and Boston, Mass.; Providence, R. I.; Hartford and New Haven, Conn.; New York City, Newark and Trenton, N. J.; and Philadelphia.

Three Eras of Transportation in India

The accompanying illustration shows one of the six Wichita 3½-ton trucks, manufactured by the Wichita Motors Company, Wichita Falls, Texas, hauling brick for Mackintosh Burn, Ltd., builders and contractors of Calcutta, India. To the left are the carts drawn by Indian buffalo which these trucks have since replaced, while above the truck are seen the natives with their baskets, which previously had been replaced by the ox carts. This illustration is interesting because it shows three eras of transportation in India.

Mackintosh Burn, Ltd., have been in

the building and contracting business at Calcutta for 15 years, and first relied upon man power to carry their building material. Each man would carry 100 lbs. of brick upon his head in the baskets shown laying at their feet in the picture, and when these men were replaced by the ox carts it was considered that great progress had been made toward more efficient and economical transportation. For a long time the oxen held sway, for it only took 1 driver and 4 men to load and unload the carts which did the same work that previously required 15 or 20 men.

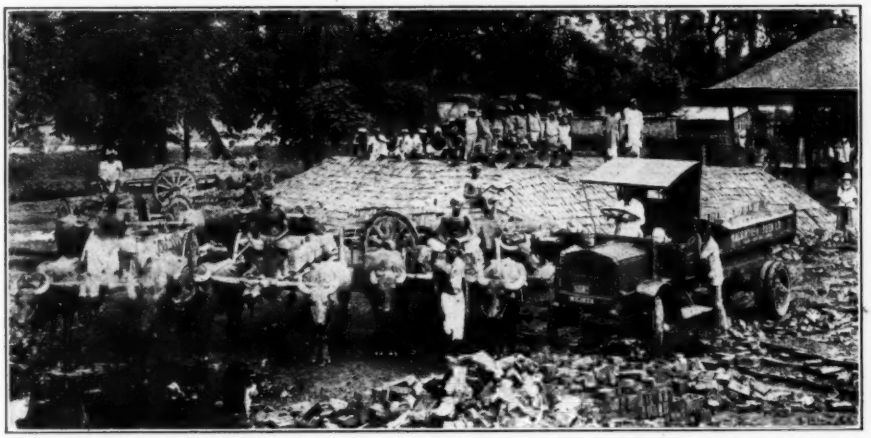
It was when this builder and contractor placed the first Wichita trucks in service that he realized a still greater advance had been made in his transportation facilities and greater economy and efficiency had been effected. Because of the extremely slow speed of the buffalo team and the time required for unloading, it was found one Wichita dump truck could do the work of 20 carts. Because of the dumping feature of the truck body, no labor was required to unload the brick, and the only time the brick were handled was in the loading.

Each of the six Wichita 3½-ton trucks which Mackintosh Burn, Ltd., operate replaced 20 buffalo carts and 100 men, each of which in its day of supremacy had taken the jobs of 15 to 20 men. Today each truck is accomplishing the same results that were accomplished 15 years ago by three hundred men.

A common laborer in India is paid one rupee per day, which would amount to about 40 cts. of our money. A daily pay roll of $120 would be required to maintain a crew necessary to do the work of one truck, even at the extreme low wage of 40 cts. per man. The daily operating cost of each 3½-ton truck is approximately thirty-seven and one-half rupees ($15), and the large saving which the trucks effect accounts for Wichita trucks being used in 83 foreign countries.

Using Trucks to Haul Stone and Builders' Supplies

Gottron Bros., of Fremont, Ohio, operate of fleet of four 3½-ton Service trucks, equipped with dump bodies and hydraulic hoists, in hauling stone, builders' supplies and coal. The first Service truck is over four years old, and the fourth was delivered in September, 1920. Gottron Brothers operate their own quarries, where stone is blasted out and loaded on trucks, both by steam shovel and portable electric conveyor.



THREE ERAS OF TRANSPORTATION IN INDIA: FIRST, THE BASKET CARRIED ON THE LABORER'S HEAD; SECOND, THE OX CART, AND, FINALLY, THE MOTOR TRUCK.

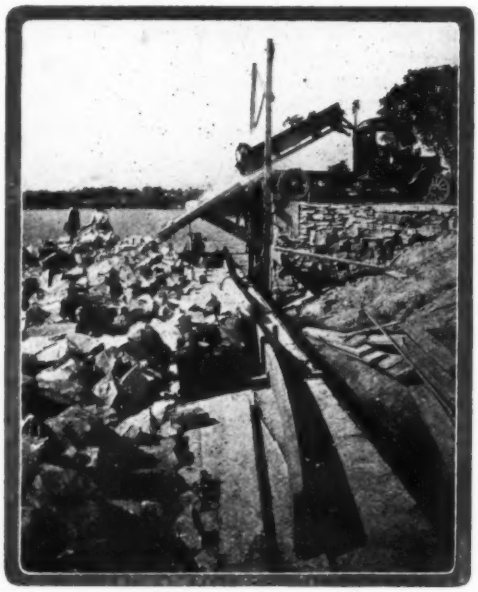
This is a typical example of the savings effected by the use of trucks over horses. Before the trucks were put in operation, the most that six horses and 18 men could haul over the 200 yds. from the quarry to the crusher was from 15 to 18 tons of rock an hour. One Service truck and six men are now delivering 40 tons an hour to the crusher.

After being crushed the stone is divided into several sizes, ranging from the fine dust, which is used in making concrete, to sizes as large as 4 ins., which is used for road work.

These different sizes are put in separate bins, under which the trucks are run to get their loads, which is dropped right into the bodies. The biggest job that these trucks have, however, is hauling from the bins and quarries to the point where the stone is used by the contractor.

From the bottom of the quarry to the point where the trucks emerge at the top is a distance of about 200 ft., in which is a rise of 35 ft. Each truck must negotiate the grade anywhere up to 20 times a day. Crushed stone is hauled any distance from 1 to 13 miles.

Gottron Brothers figure that their four 3½-ton trucks average from 85 to 100 miles a day, for a 10-hour day, but they have made as high as 106 miles a day for a two weeks' period. This, however,



SERVICE 3½-TON TRUCK DUMPING STONE TO RIVER BARGE.

was when the trips were long and only four round trips were made a day, delivering to a job a little over 13 miles from the quarry.

In addition to the stone work, Gottron Brothers have a three or four year contract for hauling stone to Sandusky Bay for riff-raffing, or filling in swamp land to preserve it for duck shooting.

Stone for this work is taken from the quarries and hauled to the river, where it is loaded on huge barges and towed about 18 miles to the dumping ground. Each barge carries about 100 tons a trip.

The oldest of these four trucks, as stated, is over four years old. It is a 3½-tonner, and for four years has been hauling the regular load of 10,300 lbs. The entire expense for the four years has been less than $700, which included two repaintings and a general overhaul one winter when work was slack. And this in spite of an accident that happened when this truck, with its regular load, went over a 30-ft. embankment on the highway a little after midnight one night when it was doing day and night service, and turned over twice in rolling down the bank. In three hours' time it was "on its feet" and started right off. There was not a broken bolt, and the only damage that was done to the truck in any way was a cracked running board.

This truck, and another of the same capacity, were over three years old before there was any mechanical overhaul at all. This is an exceptional record, for, although scientifically cushioned, these trucks have been doing the very hardest kind of work, and were heavily overloaded on each trip.

Efforts to Handicap Large Capacity Trucks

The International Motor Co., New York City, has prepared an interesting review of recent legislative attacks on large capacity trucks in New York and of the attitude of various New York newspapers toward such restrictive legislation.

On Feb. 9, 1921, the newspapers in the leading cities of New York published news items announcing a law which had been proposed in the New York Legislature to place an excessive tax on motor trucks of 5-tons capacity or over. As the law was obviously designed entirely to eliminate these large capacity units, its proposal was looked upon by many as an excellent medium for determining the trend of public sentiment in this connection.

The proposal was, of course, defeated in its early stages and on March 1 its provisions had been amended so that restriction is directed only against vehicles over 7½-ton capacity. A special news dispatch from Albany dated Feb. 14th, and published in a large number of papers read as follows regarding the public reception of the proposal: "The announcement of legislative leaders that they intend to tax heavy motor trucks off the highways has aroused a state-wide protest from commercial, industrial and agricultural interests. They contend that no proposal presented to the legislature in years has been so reactionary in its effect."

Directly following the announcement of the proposal, the New York City newspapers gave editorial expression of their views on it, which, by the way, may well be considered as a concerted voice of pub-

lic opinion. A brief glance at a few representative extracts from these editorials will therefore have particular interest.

The New York World.—"The Albany bill taxing motor trucks of five tons capacity and upward from $500 to $800 a year to drive them off the roads belongs to that large class of legislation inspired by guesswork rather than exact knowledge. It is lazy legislation.

"It is proper to tax vehicles for the maintenance of the roads—though the truck should not be asked to pay for the damage done by touring cars. It is proper to tax for proportion to weight, if the tax is not excessive. But to impose confessedly prohibitive taxes in advance of scientific study of the economics of the subject is to wrong producers and consumers by handicapping transportation developments to their common advantage."

The New York Tribune.—"The whole spirit in which this attack upon a great and growing means of cheapening communications is conceived is short-sighted and ill-advised. The prime effort of every State, of every legislature, should be to encourage the truck, to give it every chance to develop freely. Its limits of economy have by no means been reached.

"The full benefits of this new small unit of transportation cannot possibly be won if it is to be opposed and handicapped at every turn by short-sighted legislation. The broad attitude of the State should be to conform the roads to this new vehicle rather than to hamper its development and future by any arbitrary restriction of weight or size. As we build bridges to carry the big locomotives rather than to trim locomotives down to bridge capacity, so roads should be made to carry the trucks that can make the lowest rates."

The New York Herald—"It is waste of legislative breath to talk of driving heavy motor trucks off the State roads, whether with prohibitive taxes or whatever means; so long as there are votes and elections the agricultural and general industrial business of the State will never be deprived of the marvelous distributive facilities which have been built up in New York. Not only members of the legislature representing the farmers and small town manufacturers but members representing suburban communities served by the great department stores of the metropolitan centers will never listen to any proposal to put the essential trucks out of business by taking them off the State highways."

The New York Times—"It is against public policy to block the 'ship-by-truck' movement by a prohibitive tax, as the administration leaders at Albany threaten to do. Such an attempt is precisely on a level with that which the lawmakers made some years ago to banish the automobile by imposing impossible speed limits, and it is foredoomed to a similar failure.

"Already the motor truck has forced recognition as contributing to the speed, convenience, and economy of transportation. For wholesale merchants, 5-ton and 10-ton trucks make a considerable saving over all distances which the railways class as short hauls.

"What the motor truck calls for is combined regulation and accomodation, not a destructive tax."

The Brooklyn Eagle—"The proposal that the motor truck should be taxed out of existence is vicious and ought to be beaten at Albany. It is unjust to transportation interests that have become valuable to the people of the State and which can be made still more valuable in the future. It is unjust to a public which those transportation interests serve with a rapidity and facility not always assured by railway shipments.

"The influences opposing it (Shipping by Truck) at Albany are actuated by purely selfish and unworthy motives or they are ignorant of facts. In either case their effort deserves to fail."

Brooklyn Standard Union—"The reported purpose of the State to tax heavy motor trucks off the highways because they are so destructive to roads is an obviously ill-advised move. What should be done is to build the highways so that heavy trucking will not be harmful.

"The large motor truck has assumed a highly important place in the nation's freight transportation scheme and anything that curbs its usefulness is decidedly a step backward. Industry would be badly crippled if the Albany plan were generally adopted throughout the country.

"New York State cannot afford to approve any policy which turns back the wheels of progress, and this it would be doing if it yielded to the plan mentioned."

It is only natural that attempts of this kind will be made in other States either through misconception of facts or through deliberate self-interest, but no matter what their form, they cannot in any sense be permanent so long as the law of economics is sound.

What Uncle Sam Says About the Price of Cement

From "Government Control Over Prices,"
U. S. War Industries Board Price Bulletin No. 3, page 336

~~over the many practical administrative difficulties to jus-~~ the adoption of this policy. The prices fixed in 1917 yielded the cement industry as a whole 12 per cent on its investment, and of course individual mills reaped a much higher rate, but subsequent price fixing reduced this margin to 6 per cent merely by maintaining the status quo in the face of advancing costs. The general supply of cement was so ample, as compared with needs, that the Fuel Administration on April 13, 1918, reduced the fuel allotment of the cement mills to 75 per cent of normal on the theory that part of the fuel used in the cement industry could be better employed in other war industries. There was consequently no occasion for stimulating cement production by high prices, and the lowering of the margin of profit for the purpose of curtailing production was entirely justified. Cement prices rose in the open market less than any other basic building material during the war, and the reason for price fixing in the field of cement is to be found in the desire of the Government to prevent the stimulation of prices which its own large demand would normally have caused in certain congested building areas.

~~Common brick. The markets for common brick are confined~~

The following figures from U. S. Government Bulletins show average selling prices f. o. b. cars manufacturers mills, exclusive of sacks.

During the final period of Government control over prices, which ended December 31, 1918, the average factory price of portland cement as fixed by the U. S. War Industries Board was **$1.78 per barrel.** (See page 800 U. S. War Industries Board Price Bulletin No. 3.)

United States Geological Survey Press Bulletin No. 466 shows the average factory prices of portland cement for 1919 and 1920 were **$1.71 and $2.01 per barrel** respectively.

The largest single factor of cost in the production of portland cement is fuel.

The United States cement industry produced in 1920, 100,000,000 barrels of portland cement (several million barrels in excess of shipments—because of lack of cars), in the manufacture of which the equivalent of 10,000,000 tons of coal or 37,000,000 barrels of fuel oil were consumed. Compare your own 1920 and 1918 fuel bills!

The freight rate advances which occurred in 1919 and 1920 are also necessarily reflected in manufacturing costs, thus affecting factory prices.

Large wage advances to meet increased living costs have also been made to nearly 40,000 people employed in the cement industry.

Increases in these items of cost alone greatly exceed the moderate advance of 13 per cent in the 1920 average factory price over the price fixed by the Government in 1918 after its investigation of manufacturing costs.

Similar conditions undoubtedly hold in other building material industries. Since the 1920 season closed, factory prices of portland cement and other basic building materials have made very substantial declines. Producers' selling prices are in line with present manufacturing costs.

USE **CONCRETE**
FOR PERMANENCE

PORTLAND CEMENT ASSOCIATION
Organized for Service

Atlanta	Detroit	Los Angeles	Parkersburg	San Francisco
Chicago	Helena	Milwaukee	Pittsburgh	Seattle
Dallas	Indianapolis	Minneapolis	Portland, Oreg.	St. Louis
Denver	Kansas City	New York	Salt Lake City	Vancouver, B. C.
Des Moines				Washington

EDITORIALS

OUR OFFICES CONSOLIDATED

For several years this magazine has maintained offices in Indianapolis and Chicago; the mechanical and business offices have been in the former city and the editorial and advertising offices in the latter. Effective May 1, 1921, all the departments will be consolidated at Indianapolis, where the magazine has always been printed.

This consolidation is in line with the spirit of the times, of course, and is made also in the interest of improved operating efficiency. Delays occasioned by the maintenance of the separated offices will be obviated by having the editorial and printing work done in the same publishing plant.

DEMANDING CONSTRUCTION

The public is impatient of delay in the general building program, the program that is to furnish the long desired and greatly needed new homes and highways, new public buildings and constructional works of every description. Pick up any newspaper, whether a small town weekly or a metropolitan daily, and the demand for construction will be found in both news and editorial columns. Construction news is the livest news of the day, and more often than not is being given first attention in the popular press.

So great is the demand for improved highways, for example, that the most influential newspaper in the Middle West is urging their immediate construction without regard to cost, taking the position that while economies on construction may be desirable, and, if obtainable, would be acceptable, construction should not be delayed because of the price consideration. The newspaper to which reference is made argues that a good road is cheap at any price and that no price concession at all likely to be secured would be worth as much to the community as a new road. The paper in mind is widely known for the range and brilliance of its editorial pronouncements, so it is particularly significant to note that it is publishing a strong, concise good roads editorial nearly every day.

People have been sold on the idea of improved highways for some time. It seems they are now fast reaching the point where they are not only willing, but anxious to pay for good, dependable highways.

All workers in the construction industry will rejoice with us that there is now such an insistent popular demand that construction move forward. All will join us in the expression of hope that any remaining obstacles to construction shall speedily be removed.

ROAD MAINTENANCE IMPERATIVE

Engineers, contractors and public officials were undoubtedly much pleased with the attention given the highway problem by President Harding in his message to Congress. Not only did he devote a substantial portion of his message to this subject, but he shows a very gratifying appreciation and knowledge of it. His insistence that highways be properly maintained is particularly praiseworthy and his demand that guarantees of adequate maintenance be made a condition precedent to the participation in federal aid is most commendable from every point of view.

Surely the importance of highway matters was never more strikingly emphasized than by his extended discussion of them in this message, which formulates his policy and plan for legislation affecting all domestic business and international relations as well. No other form of recognition is at all comparable with this. Old workers in the highway field will be much gratified to note the high plane of importance this work has now attained.

Not only are the President's ideas sound with respect to proper maintenance of improved highways, but the very greatest good will come from his calling attention to the subject. Man is a natural builder, but he must be taught, or forced, to maintain any finished structure. Stated in other words, the building instinct is universal, every child has it, but the will to maintain must be acquired and cultivated. The child builds castles and forts with his blocks and then goes away, leaving them in such state of order or disorder as they may be in when his attention is drawn elsewhere. The man builds a fine road, or other engineering structure, and assumes it will last forever without fur-

ther attention, although there is no basis in experience for such assumption.

While the federal government can compel maintenance only on federal aid roads, such roads are intended to be exemplary in every way, and the example set in their proper maintenance will be emulated on all other roads.

FOR FORCE ACCOUNT WORK TO LEARN COSTS

In any year it is well for public officials to carry on some force account construction work to learn the true cost of such work. This will enable engineers to prepare cost estimates intelligently and will provide standards with which contractors' bids may be compared.

At this time, when prices are continually changing and it is exceedingly difficult for even the well-disposed to predict whether a contractor will get rich or go broke when awarded a contract at his own price, it is more than ever desirable that considerable force account work be carried on, under the direct charge of mature and experienced construction engineers, to evaluate construction costs. This may well be done on city, county and state jobs, not only this year, but each year until stability of prices has been restored.

Generally speaking, we believe that engineers long ago agreed that the contract system, with all its faults, is preferable to the force account system, for reasons often recited. The contract system is firmly established in theory, in practice and in basic law. There is no thought of abandoning that method of carrying on work. But the interest of all parties would now be served by adopting the suggestion that enough force account work be done so that engineers and public officials, as well as the general public, will have some guide to their judgment in passing on the fairness or unfairness of a contractor's bid. It is altogether too difficult even for the initiated to determine at present whether a contractor is "profiteering" or losing money.

We believe contractors will approve this suggestion, as it is made as much in their interest as for any other reason. It is undoubtedly true that the more force account work is carried on the more will the contract system be appreciated.

JUSTICE FOR PUBLIC UTILITIES

A remarkably effective presentation of the case of the privately owned public utility vs. adversity, intolerance, indifference, injustice, prejudice et al., appears in this issue under the title: Operating a Water Works Plant Under State Supervision. We hope every public official charged with the responsibility of dealing with such a utility will read and ponder the article, which, with admirable restraint, relates the story of the difficulties imposed by the war period, abetted by the indifferent or hostile attitude of the public toward the utilities in their darkest years.

Prior to the war the utilities were operating on a small margin of profit. If successful their earnings were limited by law; if unsuccessful they were "out of luck." They did not complain greatly, but worked hard, and, aided by the rapid urban development of the nation and the demand for modern conveniences, managed to get along fairly well. But when war sent sky high the price of everything the utilities must buy, such as labor and material, and taxes of all kinds were increased, their income remained stationary, or, at best, was grudgingly increased just enough by state commissions to prevent interruption to a vital public service. In other words, the utilities had no war profits whatsoever with which to offset advanced costs, as was the case in private industry. And all this time the utilities had to keep operating, for continuity of operation is the very essence of their function. They could not shut down entirely, or even partially, to await the return of favorable conditions before resuming full time operation, as so many private industries did and are still doing. To put it shortly, the utilities have been having a tough time of it.

That the utilities are to blame for public indifference will hardly be questioned. The managers have so long lived apart from their fellow-citizens that they scarcely could hope to be understood. Instead of seeking publicity in past years, they have practiced the suppression of even the technical news of their plants and practices, fearing or refusing to release any information whatever, even, in many instances, for publication in a technical journal, lest the information so released be turned against them. Public indifference and hostility are the direct results of such a policy of news suppression. Probably this fact is now appreciated, and if it is the utilities can still secure justice if they seek it in the right way, as recommended by the author of the article to which we have directed the reader's attention.

SPECIAL FEATURES OF IMHOFF TANK CONSTRUCTION

By George B. Gascoigne, Sanitary Engineer, in Charge Subdivision of Sewage Disposal, City Hall, Cleveland, Ohio

During the past two years it has been the privilege of the writer to design and supervise the construction of four sewage treatment plants, three of which comprise Imhoff tanks. These plants have varied in size and in many features of design, but it is the intent in this article to deal primarily with certain construction features common to such plants. Although the greater part of the information contained herein pertains to the treatment plant now under construction for the city of Cleveland at the Westerly site, the four plants previously mentioned may be listed as follows:

The Four Plants Considered

Hiram, Ohio—Population designed for, 900; plant comprises bar-gratings, two-story settling tank and open sludge-drying beds. Tank constructed in 8 ft. of hard shale, underlying 6 ft. of clay.

Vermilion, Ohio—Population designed for, 4,000; plant comprises bar-gratings, siphon beneath the Vermillion River, two-story settling tanks, disinfection equipment, open sludge-drying beds and buildings. Tanks constructed in soft silt in old river bed, necessitating coffer-dam work and continuous pumping.

Easterly Sewage Treatment Works, Cleveland, Ohio—Population designed for, 575,000; plant comprises bar-gratings, grit chambers, sluice gates, disinfection equipment, pumping equipment and buildings. Excavation in hard blue clay.

Westerly Sewage Treatment Works, Cleveland, Ohio—Population designed for, 288,000; plant comprises bar-gratings, grit-chambers, two-story settling tanks, disinfection equipment and buildings. Tanks constructed on lake front in clayey earth, necessitating coffer-dam work and continuous pumping. (See Fig. 1.)

Responsibility of Engineer.

As soon as the contract drawings for a sewage treatment works have been prepared, it is generally assumed that the duties and responsibilities of the engineer cease. As a matter of fact, however, if the engineer is to be held responsible for the successful completion and operation of the plant, he must keep in close touch with the work during its construction and be thoroughly familiar with conditions, especially as they pertain to the initial operation of the plant.

In the construction stage of the work innumerable questions relating to litigation proceedings, award of contracts, assessments, abandonment of work, selection of materials, foundation difficulties, additions and alterations, preparation of estimates, and other matters must be decided. It is practically impossible, sometimes, to obtain during the preparation of the original contract drawings, field information which will represent actual conditions. This is particularly

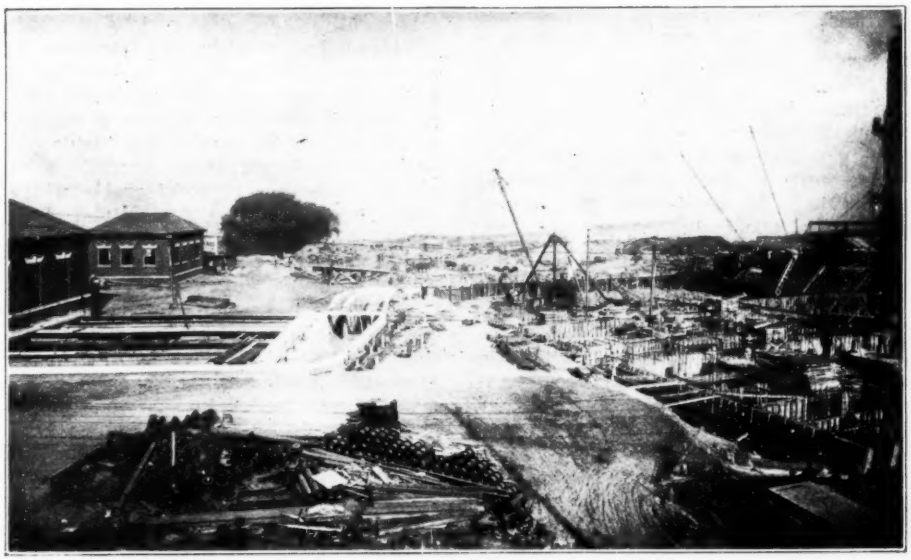


FIG. 1. GENERAL CONSTRUCTION VIEW OF WESTERLY SEWAGE TREATMENT WORKS AT CLEVELAND, OHIO.

true in the construction of large sewage works in which foundation difficulties are usually encountered. Since minor, and sometimes major changes in the contract drawings are thus made necessary, the engineer should be in close touch with the work, not only from the standpoint of protecting the interests of the owner, but of insuring the satisfactory completion of the work in accordance with the basis of design originally contemplated. There are various methods by which full responsibility for a project may be assumed by the engineer. The minimum requirements involve occasional visits during the construction period while the maximum may necessitate direct supervision by the engineer or his representative.

Necessity for Selection of Responsible Contractor

The construction of a complete sewage treatment plant can usually be divided into five general classes of work, as follows: Excavation, concrete, piping, buildings and parking. In the majority of cases it will be found that the excavation and concrete items represent from 75 to 90 per cent of the total work involved. It seems logical, therefore, in awarding contracts for the construction of sewage treatment works, that the contractor should be selected upon the basis of his ability to perform these particular items of the work in an efficient and economical manner. At the same time it should be appreciated that the minor work on such a project is important and very seldom is it possible to select a general contractor who is especially proficient in all these lines of work. The problem, therefore, becomes one of deciding between two procedures; namely, having a general contractor handle the entire work or dividing the work among a number of specialized contractors. From the standpoint of economy and of making progress, the writer has found it advisable in most instances to proceed in accordance with the former plan.

Other important factors for consideration in the selection of a responsible contractor are his financial resources, available construction equipment and the character and extent of his organization. Very often little is known about the contractor's organization, because in such specialized work, he, himself, has no accurate information upon this particular subject and must rely entirely upon his experience with work of an entirely different character.

Coffer-dam Construction

Since the construction of sewers is naturally the first step in the development of a sewerage project and, since the least expense is involved when these sewers closely parallel the surface of the ground, very little consideration is given to the future need or the probable location of a sewage treatment works. Consequently it is usually necessary to locate sewage treatment plants near rivers or bodies of water and at such elevations that foundation conditions are exceptionally difficult. In fact it may be said that coffer-dam construction is usually required in building Imhoff tanks. Furthermore, it is frequently the case that the site selected does not provide suitable foundations for tank structures, a condition which requires costly construction and involves many changes in the details of the work.

Possibly the most important questions relating to coffer-dam construction pertain to the nature of the material encountered and the most suitable method for excavating within the coffer-dam. Undoubtedly the use of steel sheeting is the method most commonly used in cases where exceptionally difficult work is anticipated, but apparently only in a few cases does the contractor consider it advisable to submit prices which will permit the use of this material. When steel sheeting is used, however, many difficulties are usually eliminated and the additional expense is found justifiable both from the standpoint of the owner and that of the contractor.

Naturally there are various methods employed for bracing the sheeting in coffer-dam construction. A decision as to the best method is usually based upon the nature and extent of the operations which are to be carried on inside the enclosure. Should these operations require a clearance of considerable width, inside bracing is usually omitted. This condition is well illustrated in Fig. 2, which shows the type of construction used in building the Imhoff tanks for Cleveland's Westerly Sewage Treatment Works. The excavated material was removed from this enclosure by means of a drag-line excavator, having a 2-yd. bucket. The material was loaded into 12-yd. standard gauge side dump cars and hauled by a standard gauge locomotive to the several spoil areas about the plant site. This excavation was carried within 18 ins. of the finished grade, the remainder of the material being removed by hand and loaded into cars by means of a clam-shell bucket. In this maner the foundations for the

tank structures were not disturbed since the material was removed only to the neat lines of the concrete work.

Testing Foundations

Soil conditions along the south shore of Lake Erie vary and to such an extent that in one location a suitable foundation may be secured, while within a very short distance from such a location conditions change entirely. It is unwise to place heavy foundations where ground is excavated along the lake front unless piles are used, although the exact location as well as the depth to which the foundation is carried and the type of loading govern to a large extent. For this reason a plan was adopted whereby the type of foundation to be used at the Westerly Sewage Treatment Works could be determined after the coffer-dam was constructed and the footings exposed. It was decided to show upon the contract drawings two schemes of foundations, one with and another without the use of piles. Furthermore, it was specified that soil tests be carried out as the excavation work progressed, the results of these tests to furnish data for a decision upon the type of foundation to be used.

Fig. 3 shows the method used in testing the soil and it may be of interest to describe the way the loads were applied. Attention is called to the depth of the tested area below the surrounding

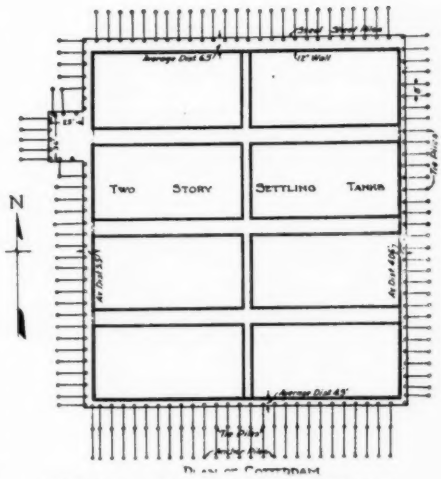


FIG. 2A. PLAN OF COFFERDAM.

area as being equal to the length of the longest side of the area tested. Bags containing iron ore and weighing 100 lbs. each were placed on the platform and used in obtaining the desired loading. The loads were applied in increments of 100 lbs. per sq. ft. and time intervals allowed for such duration as to note the cessation of movement. Loads were added until a value per square foot equivalent to the weight of the tanks when empty was reached. The loading was then stopped, but as soon as all settling movement had occurred, the load was again increased until its weight was equal to that of the tanks when filled with water. The loadings were stopped again, but were later increased, using the same time

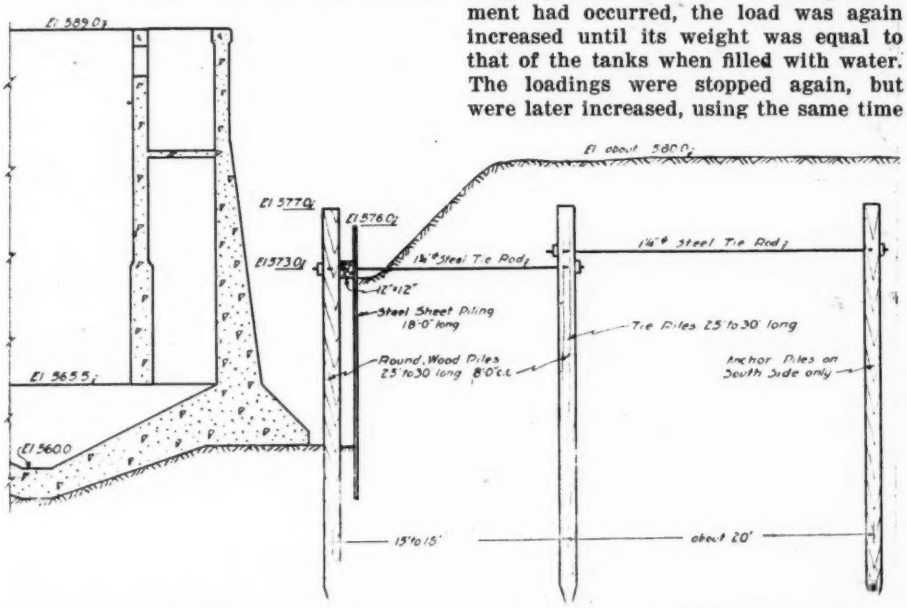


FIG. 2. COFFERDAM CONSTRUCTION, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO, SHOWING TYPICAL SECTION THROUGH TANKS AND COFFERDAM.

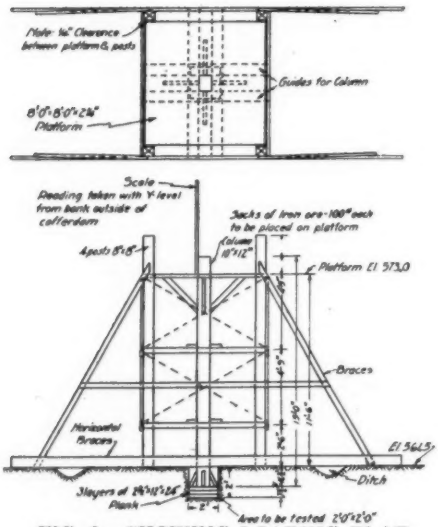


FIG. 3. SHOWING LOADING PLATFORM FOR SOIL BEARING TESTS. WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

intervals, until double the weight of the tanks when empty and full was reached. The loadings were then increased to three and four times the tank loads when empty and fully loaded. Finally the soil was loaded to what was considered failure or until the platform kept settling without the addition of loads and a total settlement of 7 or 8 ins. had been reached. Six loading tests were made within the 200 ft. sq. area and the results plotted as curves which showed the behavior of each test. From the curves the safe loading was determined as well as the amount of settlement which could be expected. In no case was a settlement less than ⅛ in. found with loads which would be imposed when the tanks were full. On the other hand what was termed as complete failure did not occur until loads approximately four times the full load were used.

Concrete Work

Probably the most interesting feature of the Westerly work to date is the method used in constructing the tank bottoms. Prior to the award of the contract and as soon as expedient thereafter, the program and methods of construction which were contemplated were discussed thoroughly. It was found that the contractor intended excavating the bottoms to the hoppered shape, placing the steel on small concrete blocks, wiring the wall steel to racks and pouring the concrete of such consistency as to stand on the slopes (1 on 2) without the use of inside forms.

The bottoms were found to consist of

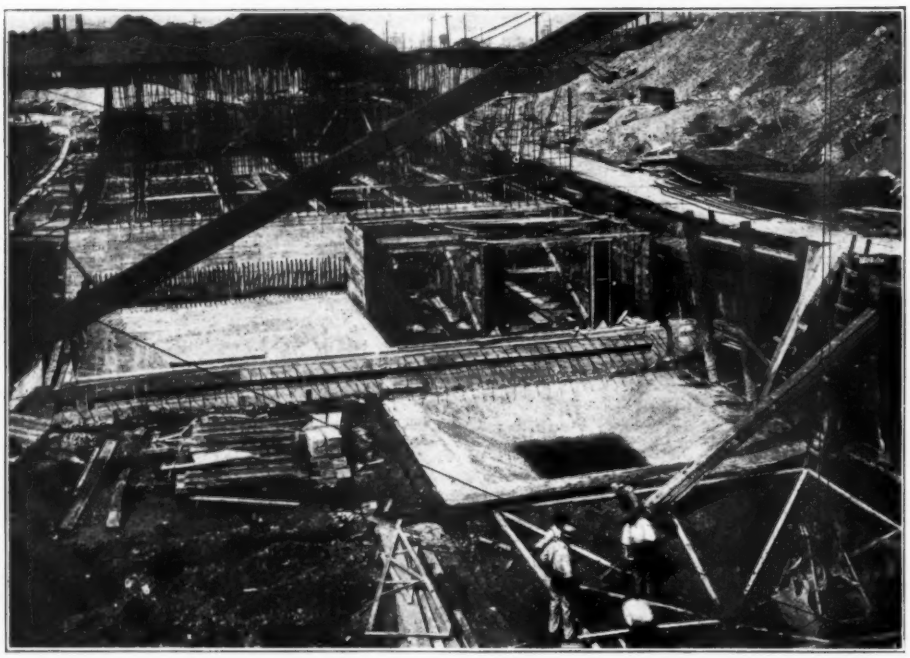


FIG. 4. METHOD OF CONSTRUCTING CONCRETE FLOOR OF IMHOFF TANKS IN WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

a rather heavy, yet firm, blue clay which when wet would make working in it almost impossible. It would "churn" up, cover the steel and seriously interfere with efficient labor. After considerable discussion it was decided to proceed with the concrete work of the hopper bottoms by excavating to a grade 2 ins. below the neat lines and place screed boards (2x4 in.) in the valleys of the hoppers along the middle of each side and around the top. A 2-in. layer or floor of concrete was then placed over the bottom and screeded down flush with boards. (See Fig. 4.) This layer of concrete was then given a chance to set before any attempt was made to work upon it. The floor steel was then readily placed, wired and supported off the floor with 2-in. concrete blocks. The steel in the upper portion of the hoppers was wired to inside forms instead of being supported on racks as may be seen in Figs. 5 and 6. The forms were then lowered into place and rested on concrete blocks 6 ins. by 12 ins. by 42 ins. and wedged to the proper elevation. The wall steel was then put in place and wired to a 2-in. by 4-in. strip along the edge of the hopper, the 2x4's being marked off for the correct spacing and bulkheads were then built and the concrete poured to a depth of about 2 ft. over the floor, to elevation 562.5. The blocking or wedges supporting the forms could then be removed without danger of settlement of the inside hopper form. The remainder of the concrete in the hopper was then poured.

The 2-in. working floor of concrete prevented the steel becoming covered with mud and enabled the steel men to work expeditiously since they were on a clean concrete floor instead of in mud. The inside forms gave a better wiring surface for placing the upper layer of steel than the racks and permitted the contractor to place the concrete and spade it more thoroughly by not having to make it as dry as would be necessary without forms. Also the forms provided a good support for the wall steel. The 2-in. floor insured getting clean concrete through the entire mass. The savings by the false floor method of construction were greatly to the advantage of the contractor and valuable to the city because of the quality of concrete and sureness in keeping the steel in place.

The concrete was mixed in a Lakewood outfit, a ¾-yd. mixer being used, and the receiving bins and distribution system having an eight-hour capacity of about 300 cu. yds. It was distributed by means of elevated steel chutes which terminated at the forms in a secondary hopper from which other chutes delivered it to the forms proper. The secondary hopper was built large enough to hold four or five batches and had openings on four sides so that the concrete could be

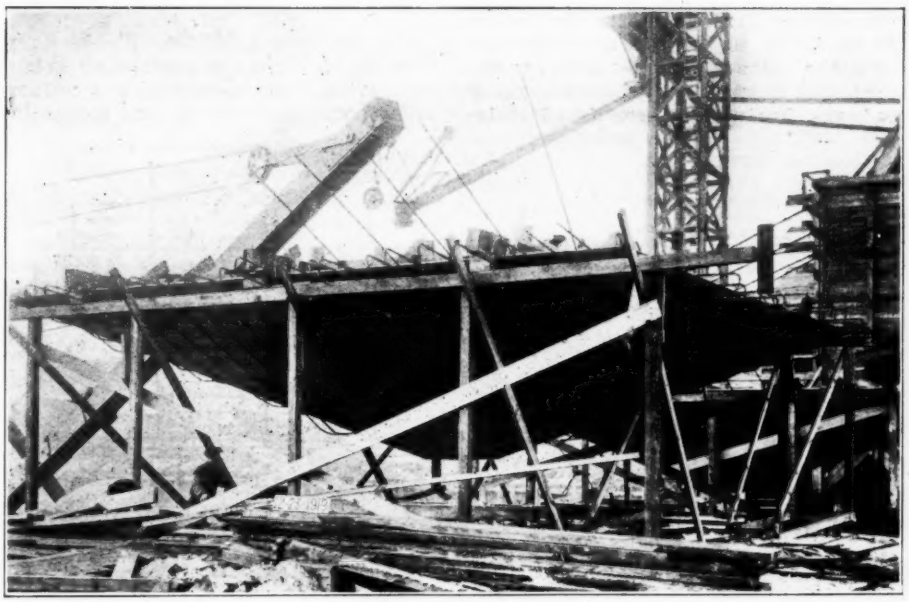


FIG. 5. RACKS FOR SUPPORTING STEEL IN IMHOFF TANK CONSTRUCTION, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

run in any direction by means of short wooden chutes. The mixing in the secondary hopper practically prevented poorly mixed or poorly proportioned concrete reaching the forms. Moving of chutes could be effected without stopping the mixer, because of the capacity of the secondary hopper and running the concrete into the forms in four places prevented it from setting up in one place while it was being poured in another. In pouring long walls, or more than one tank bottom, two or more secondary mixing hoppers were used, the only change required in the main or steel chutes being from one hopper to another.

Buildings and Parking.

It is observed that for some reason or other not enough attention has been given in the past to the necessity of buildings about a sewage treatment plant. Many times there are no buildings at all. These statements apply in particular to the smaller-sized plants where the need of them is great. On larger plants the buildings are complicated somewhat since they require plumbing, electrical wiring, heating systems and drainage. On the smaller plants the buildings are used normally as a storehouse for tools and a place to shelter the attendant in times of bad weather.

In keeping with the necessity and substantiality of the buildings is the upkeep and attractiveness of the surrounding grounds. The disrepute in which many sewage plants find themselves today can be traced to the bad appearance of the works. Money spent for parking purposes, such as walks, seeding, sodding and roadways, has usually been found to be justified and this is particularly true should the works lack isolation.

General

Mr. Robert Hoffman is commissioner of the Division of Engineering and Construction for the city of Cleveland, of which the Subdivision of Sewage Disposal is a part. The work of design and construction herein described is under the supervision of the writer. J. M. Heffelfinger and A. A. Burger are the resident engineers in immediate charge of construction, and the Masters and Mullen Construction Company and the American Construction Company, both of Cleveland, are the contractors for the Westerly and Easterly plants, respectively. J. D. Price was the resident engineer in immediate charge of construction and the American Construction Company was the contractor for the Vermilion Sewage Disposal Works. A. C. Schlobohm was the resident engineer in immediate charge of constructing the Hiram Sewage Disposal Plant, and the work was done by the owner upon the direct labor basis.

LETTING GRADING AND BRIDGE CONTRACTS ON ILLINOIS STATE BOND ISSUE ROADS

By C. M. Hathaway, District Engineer, Illinois State Division of Highways, Effingham, Ill.

For the year 1920 the Illinois State Division of Highways planned an extensive paving program on the sixty million dollar bond issue system, and it was in-

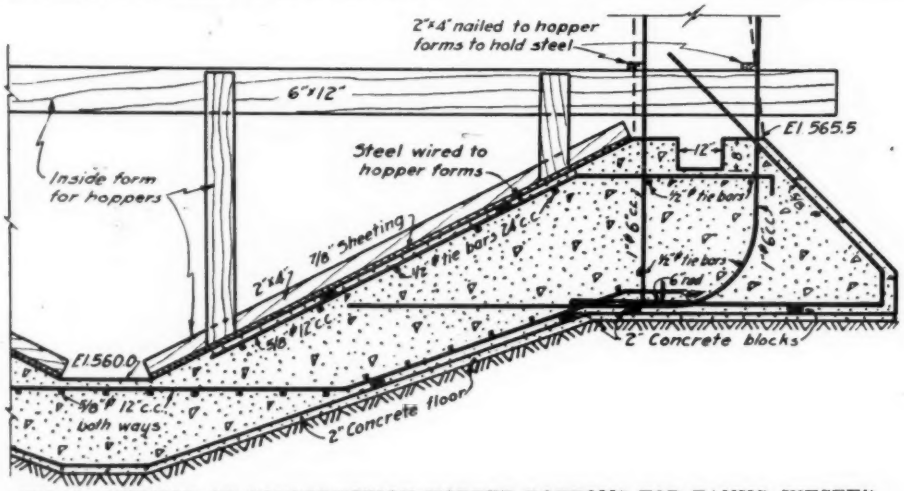


FIG. 6. METHOD OF CONSTRUCTION HOPPER BOTTOMS FOR TANKS, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

tended to put under contract during the season 1,000 miles of paving work.

Because of the high prices then prevailing and the scarcity of cars and labor it became apparent after the first bids were received that paving work at a reasonable figure was out of question and it was, therefore, definitely decided that the anticipated program for the season of 1920 would have to be abandoned and that construction work with respect to paving would have to be confined almost entirely to completing existing contracts.

Earth Grading and Bridge Work in Advance of Paving

It was felt, however, that something could be accomplished by doing the earth grading in certain sections of the state, where there was involved a great amount of heavy grading and bridge work, confining this work specifically to those instances where it would be necessary for the heavy fills to settle at least a year before the pavement could be placed and where new alignment must be established and heavy grades reduced. The construction of bridges of long span is also somewhat of a drawback on a paving job and it was also decided that this work should be done in advance.

Definition of Grading Sections.

As a rule grading sections were considered as those where the earthwork ran higher than 6,000 cu. yds. per mile or where fills ran in excess of 3 ft. In some cases these sections were in continuous stretches 5 to 6 miles in length and in others broken sections comprising short fills or short stretches of rough country of one half- mile or more in length with the level ground between.

In placing the minimum limit at 6,000 cu yds. it was felt that when the yardage ran less than this it would not be economy to undertake the grading until the paving work was started.

Special Earth Road Section Designed.

A special earth road section designed to take into account work of this sort is shown by Fig. 1. Referring to this cross section it will be noted that the section used is such that the grade of the finished roadway is practically the same as that proposed for the finished pavement and as completed is such that when the paving work is undertaken it will require only the moving of such earth as may be necessary to place the slab without necessity of moving additional material from the ditches or side banks. In other words, an ordinary plow and grader should open up subgrade at small expense and on completion of the pavement the earth thus thrown out may be graded back against the pavement for the 6 ft. earth shoulder on each side. It is estimated that when the paving sections are completed there will be involved not to exceed 2,000 cu. yds. of earth work. As a general rule, bridges occur coincident with the heavy fills and at other points in the grading sections, although in some instances the construction of bridges was undertaken where there were no grading sections.

130 Miles of Heavy Grading and 84 Bridges

Following out this plan there was put under contract during 1920 130 miles of heavy grading and 84 bridges. Upon inviting bids for these several sections of work it was found that there were seemingly a sufficient number of grading contractors willing to take such work at a reasonable price, considering labor conditions and the same condition was also true with the bridge contracts.

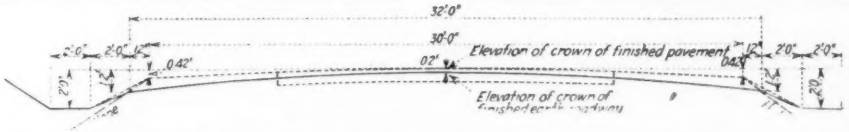


FIG. 1. SPECIAL EARTH ROAD SECTION FOR GRADING ROADS TO BE PAVED IN ILLINOIS.
Dotted Lines Indicate Original Pavement Cross Section. Solid Lines Indicate Cross Section to which Earth Roadway is to be Graded.

The first contracts awarded showed some disposition on the part of contractors to be skeptical of conditions and the prices accordingly ranged somewhat higher than was at first anticipated. Further lettings, however, showed a marked decrease in bid prices and a more marked competition indicating that this class of work was very desirable and could be readily disposed of. This situation did not quite apply to the bridge work, since the bids on bridges were all uniformly higher than had been estimated, which evidently indicated that the bridge contracts were still being affected by existing uncertainties of labor, shipments of materials, etc. In no instance,

however, was there ever any lack of bidders on a section.

Selected Sections Well Scattered.

In selecting sections, the work was well scattered over the entire state with respect to location and railroad shipping points, and as construction proceeded it became plainly evident that the department had not figured unwisely in awarding the work which it did. With respect to bridges, the contractors were able to get desirable shipments of materials with practically no delay and were always able to secure the necessary labor, either from their regular gangs or locally. The grading contractors were especially well able to secure teams and labor and in numerous cases the supply of "subs" looking for work exceeded the demand.

The Plan An Unqualified Success

Although the first contracts were not let until about August 15 and from then on until October, nevertheless, in each case a surprisingly short time was taken to get under way, and of the 40 miles of grading and 53 bridges put under contract in the writer's territory, about 70% of the grading was entirely completed by cold weather and 20 of the bridges were entirely completed with 27 over 50% completed. As a result it is apparent that where all heavy grades were reduced, all relocations made, all poor alignments remedied, and all heavy fills made ready for an extensive paving program, the scheme has proved an unqualified success, this especially when one realizes the usual difficulty of the paving contractor in keeping ahead with heavy grading operations and the delays and financial loss due to omitting the paving over heavy fills and later moving back.

Exclusive Grading Men Attracted

In addition it attracted the exclusive grading men to the job with outfits adequate to handle dirt. It was especially noticeable that many men who habitually shunned the paving work were only too eager to handle a grading job. In other words it has attracted a new line of contractors, who had not previously shown an inclination to bid, men, too big to "sub" the grading work on an average paving job, who saw a large enough yardage to afford the utilization of their machinery and equipment to economic advantage to themselves and to the state.

Separating Bridge and Grading Contracts on Same Section

In connection with work of this sort there was instituted a practice which has been much discussed by members of the department and the experience which was gained therefrom may be of some value to the readers of Municipal and County Engineering, namely, the separation of bridge construction from grading even though the bridges were included in the limits of the grading section. Previous opinion had been that bridges and grading should, as a rule, be combined, since it was feared that having two contractors on one job might lead to numerous difficulties and be the cause of repeated controversy.

Contractors Favored Separation.

When the question of grading contracts came up, however, there were requests by both grading contractors and bridge contractors for this separation, since it is a well known fact that the grading contractor is usually equipped to handle grading work only, while the average bridge contractor is equipped to handle bridge work only.

Where one must overlap the other, it may result in two things: First, the grading contractor being unfamiliar with bridges naturally raises his prices on the bridge work to take into account his unfamiliarity with the work, while the bridge contractor, not familiar with grading work on a large scale and not equipped, is not in position to make a rational and economic bid on the grading work. Second, if let together the grading contractor may underestimate his bridge requirements and will "sub" this work to a less desirable man than the regularly qualified bridge contractor, while, on the other hand, the bridge man bidding on the basis of his knowledge of bridge work will give the grading operations secondary consideration. Therefore, after giving this matter consideration in the light of the numerous pleas for the separation of such contracts it was decided to separate grading and bridge sections wherever practical and where the bridge work was of sufficient magnitude to justify such a course. The grading contractor, however, was called upon to construct the usual small cross road culverts and private entrance culverts along the line of his grade since these particular culverts are always so numerous and so situated that it would be impracticable to separate them from the grading work.

Two Methods of Limiting Jurisdiction

Two schemes were tried, one, making a deduction from the grading contract about 100 ft. back from the face of each abutment of the bridge and specifying that the bridge contractor should make the fill within those limits, this to allow

him storage and working room; second, requiring the grading contractor to make the entire fill up to the back of each abutment.

Special Specifications to Insure Co-operation

In order that there might be no confusion between the two contractors, special specifications were inserted in each instance, which specifications may be quoted in brief:

"Co-operation between the contractors. The contractor shall handle the work of this contract so as not to interfere with the operations or work of the contractor for the bridges not included in this contract and laying within or adjacent to this section and located at Stations .... on the contract designated as project No. ..... The contractor hereby assumes all responsibility, financial or otherwise, for work not completed and accepted, and further agrees to protect the state from all damages or claims due to any inconvenience, delay or loss encountered by said contractor on account of the presence and operations of the contractor for the above mentioned bridges.

"The contractor for the above mentioned bridges will be required likewise to carry on his operations so as not to cause undue delay to the contractor for this section. Both contractors will be required to co-operate with each other, and in case of any dispute the decision of the engineer shall be final and binding upon both alike.

"Priority of work. The construction of the abutments for the bridge at station ..... shall take precedence over any other work to be done under this contract and shall be completed as soon as possible after the award of the contract. The construction of the east abutment shall precede the construction of the west abutment.

"The construction of the abutments for the bridge at station ..... shall take precedence over any work to be done on the bridges at stations ..... and shall be completed as soon as possible after the award of the contract. The construction of the north abutment and backfill shall precede the construction of the south abutment."

It will be noted from the above specifications that the grading contractor is held responsible for the fill, while the bridge contractor is held responsible for certain definite operations in connection with construction of his abutments.

In addition to the "special provisions" the two successful contractors were called together before starting work and the entire proposition was discussed very carefully so that each would be familiar with the obligations and intentions of the other.

In the writer's district there were 22 individual sections on which the bridges were separated from the grading, although some were combination sections, and since practically all 22 sections were either completed or well under way by January 1, there was afforded a chance to study the working out of the method.

Contractors Do Not Clash.

The writer has watched this proposition with considerable interest and to date there has not been noted a single accountable difference between contractors. In one or two instances slight difficulties did arise, but the engineer always got the two contractors together and, after a careful analysis of conditions, there was effected a peaceable and satisfactory settlement.

In short, it would appear that no more trouble need be anticipated on a proposition of this sort than usually arises between a contractor and his "sub" under similar conditions. Each contractor seemed to realize his obligations and evidenced his willingness to accede to them.

With respect to omitting a small section of grading adjacent to the bridge for the benefit of the bridge contractor's working force, as contrasted with the proposition of having the grading contractor construct the entire fill, there did not seem to be a marked difference in either scheme, although observation at present tends to indicate that it is fully as desirable to let the grading contractor make the entire fill and thus relieve the bridge contractor of any grading work. At first, thought it may appear strange that this matter worked out as it did, yet it seems that the two contractors are able to work in such harmony that there is no apparent confusion and in several instances where the grading contractor had the work practically completed except the back fill at the abutments he made a private arrangement with the bridge contractor whereby the latter should complete the work and where the bridge contractor needed a small space for storage or plant, he made a similar arrangement. The latter scheme is now followed in new work.

Conclusion

In conclusion it would appear that the inference to be drawn from these last paragraphs is that better and more reli-

able contractors for their own specific lines of work can be obtained by following out the course just referred to and that, just as in the case of separating heavy grading from the paving, so also it would seem desirable from a practical and financial standpoint to separate all large bridge work from the grading.

In short, the 1920 experience along this line has shown a marked preference to continuance of the system of letting grading contracts strictly to grading men and bridge contracts strictly to bridge men.

ANALYSES AND PREPARATION OF HIGHWAY COST ESTIMATES

By H. J. Kuelling, Construction Engineer, Wisconsin Highway Commission, State House, Madison, Wis.

In view of the rapidly changing economic conditions in the past few years and the uncertainty as to future years, estimates have been giving, and are going to give, highway engineers considerable trouble. There has been and there will be great doubt as to whether or not bids should be accepted. The uncertainties have been very great in recent years, and largely against the contractor. Apparently there is a reversal coming and the uncertainties will now be against the states. This means that it is all the more urgent that proper estimates be made on highway work.

The question of estimating will be discussed in this paper from the standpoint of a state department and not from the standpoint of an individual, said Mr. Kuelling, in addressing the recent annual meeting of the American Association of State Highway Officials.

It is assumed by the writer that the economical type to be constructed has been previously selected. This statement is made because of the fact that in making estimates, factors are very often uncovered which warrant a change in type.

Collecting Local Information

Before any figures are made on an estimate, the engineer must carefully analyze all conditions surrounding the work. In other words, he must spend time in seeking out all local information relative to every feature of the work. This local information may pertain to availability of materials; freight rates; railroad accommodations, as to sidings and train service; camp sites; water supply for these camps; availability of supplies for this camp, whether they come from merchants or farmers; the soil conditions, whether or not they are conducive to a small weather loss; whether the sand is so soft that it will interfere with the movement of his equipment, such as wheelers, or wagons; the kind of clearing and grubbing he has, whether they are deep-rooted trees or flat-rooted; the type of marsh conditions, if there are any, whether it is possible to work horses or equipment on them; the kind of grades that may be encountered in the work, which will have a bearing on the hauling of materials, or the pumping of water; in fact, he must seek information on a great variety of subjects.

Information on Local Materials

In seeking knowledge of materials he must know the capabilities of commercial concerns to ship, whether they are in a position to get cars, whether they have the proper capacity to turn out the amount of material they are likely to contract for; whether their material is satisfactory; the business reputation of the concern, as to whether they will keep their word or not—that is, whether they will ship in accordance with promises, or whether they will ship to some one that comes along and offers them a higher price at a later date.

Seeking information on local materials, the engineer must be even more careful, as he must know the kind of materials available, the amount of it, especially if it is a gravel deposit, as these are likely to pinch out; he must know the cost of it, and he should have an option on it, so that one contractor, by getting this option, cannot bar others from bidding.

The mere investigation of present used materials is not sufficient, as there are many cases where materials are being hauled several miles when there is a sufficiently good supply within a very short distance from the job. Entirely new and unknown sources of supply can be found in any state by a painstaking materials department. The changes of the freight rates, if there are any new increases, should be balanced against the extra distance that local materials can be hauled.

After an engineer has obtained or been furnished with all this local color, he is still very much handicapped in making his estimate, unless he has had considerable experience in actual construction. He should know the best methods of carrying on the work, what equipment to use, whether it be a grading or surfacing job.

Do Some Work by Force Account to Learn Facts

With the amount of work that is being

done and will be done by every state in the Union, the simplest, most practical and only satisfactory way to get this cost information is for the various states to do some of their work by force account. The writer knows that some states cannot legally do this, but believes that provision should be made so that they may. It will be surprising to many to find out the items that crop up and that must be paid for on a construction job. Some things are hard for an engineer to realize unless he has been through the mill; things which he is likely to criticise the contractors for including in their estimates.

Wisconsin has taken this stand for years past and has done a very great amount of certain types of work by force account. Up until the time of federal construction this force account work was entirely in the hands of the county authorities and only under the general supervision of the state. Since the federal construction began, the state has undertaken a number of jobs by day labor, and, in fact, in 25 of the 71 counties during the past season part of the work has been done in this way. This does not mean that the majority, or even a large per cent., of the work is done by force account, but enough is done so that the state will have first-hand and absolute knowledge of costs.

Range of Force Account Jobs in Wisconsin

Owing to the variety of work and variety of conditions, there is required several force account jobs along different lines. For instance, on concrete road construction during the past season, one job was run by day labor where the material was dumped on the subgrade and handled by wheelbarrows. This material was shipped in from commercial plants to a special siding, transferred by a clam to side dump cars on an electric railway, which ran along the highway and dumped directly onto the subgrade. In another case a local pit was developed and the material hauled to the road by trucks; it was then mixed and placed, the mixer being loaded with wheelbarrows. In a third case a local pit was used, the concrete mixed at the pit, hauled in a mixed condition by industrial railway and placed on the subgrade with a large crane.

In grading operations one job was undertaken in a sandy soil; one in a gravelly soil; one in clay soil; still another in very stony ground. Some work was done by steam shovels and some by wheelers and fresnoes.

In a similar manner various kinds of gravel work were undertaken. Some with sandy gravel, some with clay gravel and some with gravel that would hardly be worthy of the name of gravel; in other words, it was really top soil.

With an accurate cost analysis of all this work at hand, we feel that we are in much better position to determine whether or not the bids submitted to us are satisfactory.

After progressing thus far in the making of an estimate, the writer believes that the states should have a regular system of making these estimates; in fact, he sees no reason why a committee from this organization could not develop a scheme, or schemes, for having all the states make their estimates in the same manner. This scheme, whatever it may be, should be after the same fashion, and, in fact, can well be the very same forms that a contractor should use. There is no reason why the drawing up of such estimate forms could not be partly done by the contractors, or in conjunction with them.

This scheme of having the contractors work with the engineers has been tried out during the past year in Wisconsin, with more or less success.

Form for Making Estimates

A year ago the Wisconsin State Highway Department called a two-day meeting of contractors, machinery men, material producers and the engineers of the state. A very open discussion was had regarding the relations of all parties concerned. At this meeting a committee was appointed and instructed to draw up a form for making estimates. This committee was composed of five contractors, elected by the vote of the contractors themselves, one man from the aggregate producers, one man from the machinery manufacturers, three men from the county construction departments, and two from the State Highway Department. This gave a committee of five engineers, five contractors and two others who were vitally interested in the meeting. This committee met for three different sessions and they were sessions at which work was done. The contractors, as a rule, were frank in their statements, and out of it grew an estimate form for one type of construction which seems to be fairly satisfactory to all concerned. No doubt it has many faults as yet, but it is a start in the right direction. This form is drawn up primarily for a concrete road job, but it can be very easily adjusted to other types of surfacing. The committee did not com-

plete an outline for estimating grading work, but it is hoped that they will do so some time in the near future. They did, however, touch upon certain features of it.

There is perhaps more guessing done in making grading estimates than in any other kind of road work. There is a greater need for some satisfactory method for estimating grading costs than for most kinds of road work. Too often the average haul is not even known. A greater use of the mass diagram would be beneficial.

The attendance of this committee was was almost 100 per cent. and the meetings were lively, as many discussions arose. All points were finally amicably settled and the form is used quite freely throughout the state.

The Form as Developed

The form as developed is divided into 16 subdivisions, as follows: Cost of sidings; moving of equipment to the job; lost time of moving equipment; cement; fine aggregate; coarse aggregate; surfacing; camp loss; miscellaneous cost; contingencies; compensation and public liability insurance; bond cost; overhead; profit; charges for machinery and equipment. Each of these items is subdivided into as many divisions as were considered necessary by the committee. Most of these items are somewhat easy to determine, but others are not. Only a few will be discussed here.

Overhead

Overhead, the committee finally put on a percentage basis. For instance, in figuring a job the contractor or the engineer would have to estimate the per cent. of the manager's time that would be required for the job, and then charge up that per cent. of his yearly salary to the job. The same with regard to his office force, timekeepers, the expense of the manager, his office rent, supplies, etc.

Overhead also includes the corporation insurance, interest on the necessary working capital and any dues that might have to be paid to associations.

Profit

Under the item "Profit" I might say that the committee had a rather heated argument. Naturally the contractors were anxious to obtain as much profit as possible and have the state officials agree to certain percentages. This, however, we refused to do, and the per cent. of profit was left blank for the contractor to fill in as he desired. What we were seeking was primarily to get every one to make his estimate along the same line and then let the contractor be his own judge on whether or not he could get the job with certain profits added on.

Machinery and Equipment

In the last item, charges for machinery and equipment, the committee had perhaps the most interesting discussions. Charges for surfacing, machinery and equipment were worked out to certain percentages per mile of road constructed. For instance, under concrete pavers, we assume that the paver will build 30 miles of standard 18-ft. road, at the end of which time it would be completely used up. The same result was obtained if we assumed that it would build 24 miles and at the end of that time have a salvage value of 20 per cent. of the original cost. With the 30 miles noted above, and an average per year of 6 miles, the life of the mixer would be 5 years. Depreciation, therefore, in 5 years equals 100 per cent. Repairs in 5 years at 10 per cent. would equal 50 per cent. of the original cost. Interest, storage and insurance, 30 per cent. of the original cost, making a total of 180 per cent. of the total cost, to be spread over 30 miles, or 6 per cent. per mile. In other words, in figuring the charges for machinery, the contractor, if it was a standard 18-ft. road, would merely multiply the number of miles by 6 per cent. and take that per cent of the original cost of his paver as the amount to be charged to the particular job under estimation. In a similar manner the committee arrived at percentages for various types of equipment used in the surfacing work.

Grading and Hauling Equipment

The per cent. on grading and hauling equipment naturally could not be arranged by miles. It must be worked on a time basis, and cannot be as accurately determined as surfacing equipment, because of the greater variation in quantity and kind of excavation in different jobs. Final percentages have not as yet been arrived at by the committee for these types. The committee did state that including depreciation, interest on investment, storage, insurance and all repairs, but not including fuel, the percentage per operating day would vary from ¼ per cent. to ½ per cent. of the original cost, depending upon the kind of equipment.

There is no doubt that a continued use of this form will bring out points of weakness, but the writer believes it is a step in the right direction and that within a very few years standard forms of estimating will be in use for road work, and that there is no reason why these same forms

cannot be used both by the contractors and by the engineers.

There is also no doubt that adjustments will have to be made for certain local conditions which are not covered. Where there is something to guide, there is no reason why the contractor and the engineer should not be a little more in harmony than they have been in some cases in the past.

Short cuts in estimating are needed and can be devised by state departments. Care should be taken, however, not to make these too short. No scheme will ever be devised or charts drawn so that a novice can make highway estimates. It is only by the use of brain and knowledge of conditions influencing costs that proper estimates can be made.

THE RELATION BETWEEN THE FLOOD FLOW OF STREAMS AND INTENSITY OF RAINFALL

By Harrison P. Eddy, of Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

In the absence of definite information upon maximum rates of flood flow in streams it often becomes necessary in flood protection problems to make an estimate of the probable maximum flood flow based upon the probable maximum rates of rainfall for various durations; in other words, to apply what is known as the Rational Method of design of storm water channels, which is now a method commonly followed in design of storm water drains.

The whole of the rain which falls on the surface of the ground does not pass off into the brooks and streams. A portion of it enters the earth and becomes a part of the ground water; some is absorbed by vegetation, and some is returned to the atmosphere by evaporation. The proportion of the rainfall which runs off over the surface into the streams varies considerably due to changing conditions. Some of the rain which eventually reaches the streams does not run off quickly, but is retarded by vegetation, and by depressions in the surface of the ground. When the soil is dry it will absorb a much larger quantity of water than when it is water soaked, as just after a long rain. The character of the soil, whether of clay and of an impervious nature, or of gravel and sand and of a porous character, greatly affects the amount of water which runs off and also the rate of run-off. The presence of considerable rock increases the imperviousness of the surface.

With rains of high intensity covering periods of 24 hours or more, the rate of run-off is greater than in the case of short-time storms of similar intensity because the soil becomes more thoroughly water soaked, vegetation is drenched, the rate of evaporation is reduced and small depressions in the surface of the ground are no longer capable of retaining additional water.

There are comparatively few reliable measurements available showing the relation of the run-off to rainfall, especially for rains of high intensity and long duration.

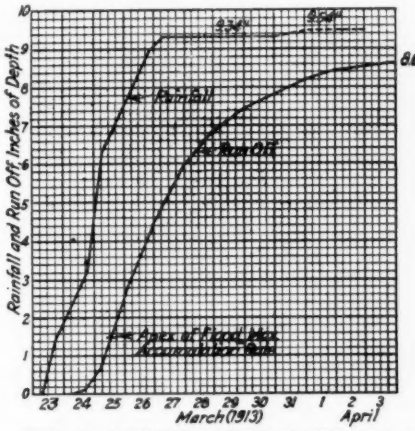


FIG. 1. ACCUMULATED RAINFALL ON THE SCIOTO WATERSHED AND THE ACCUMULATED RUN-OFF AT THE COLUMBUS STORAGE DAM.

Drainage Area, 1,050 Sq. Miles. Storm of March, 1913.

Some measurements have been made of the run-off from sewered areas, but these are of little value in estimating the run-off from a drainage area where the amount of impervious surface such as roofs and pavements is small compared with the proportion of the same in urban districts which are sewered. Records of this kind indicate rates of run-off as high as 85 percent of the rainfall for short storms of high intensity, and from that figure down to an average of perhaps 50 percent.

The best available records of run-off for a long-time storm of high intensity are those of the Scioto River near Columbus, Ohio, and the Miami River at Dayton, Ohio, for the storm and flood of March 23-27, 1913.

Scioto River Run-off

Data on the rainfall and run-off of the

Scioto River for the March 1913 storm are given in Report of Alvord and Burdick on Flood Protection for the City of Columbus, Ohio, September 15, 1913, pp. 50, 78, etc. and Mead's Hydrology, p. 568.

The amount and rates of rainfall were observed at a number of stations in and near the watershed, making it possible to compute the average rates of rainfall for the whole watershed with reasonable accuracy.

The run-off or river discharge was computed from the records of the depths of flow over the Columbus storage dam, a masonry dam of the overflow ogee type having a rounded crest. Experiments were available to determine the coefficient of discharge of such a dam with a fair degree of accuracy. The run-off was also corroborated by data on gage heights of the river at other points.

Fig. 1 shows the accumulated rainfall on the Scioto River watershed and the accumulated run-off at the dam.

The principal data are as follows:

Drainage area of Scioto River above Columbus storage dam* (U. S. G. S. revised), 1,050 sq. mi.

Average slope of Scioto River for 40 miles above Columbus and the junction with the Olentangy River, 4 ft. per mi.

River flows for 20 to 25 miles above Columbus through a rock gorge with steep sides 50 to 100 ft. in depth and from 500 to 4,000 ft. in bottom width. Bottom lands not fertile.

Large natural storage reservoir on upper part of watershed consisting of large area of level land receiving drainage from 100 sq. mi. of watershed and developed into market garden farms. Stored water during flood and for 3 weeks thereafter.

"The lower two-thirds of the watershed above Columbus, therefore, really contributed the water which created the crest of the flood at Columbus of such proportions." (Alvord and Burdick-Columbus Flood Protection Rept., 1915, p. 129.)

Rainfall on Scioto Watershed (Mar. 23-27, 1913), 94 hours, 9.34-ins.

Run-off of Scioto River at Dam (Mar. 23-April 3, 1913), 258 hours, 8.68-ins.

Ratio, 93 percent.

Rain began to fall about 6 a. m., Mar. 23.

River began to rise about 6 a. m. Mar. 24.

River began to rise rapidly about noon, Mar. 24.

Maximum flood rate in river occurred about noon, Mar. 28, following period of intense rain which began 18 hours earlier.

Period of concentration on river apparently about 30 hours at beginning of storm.

*Alvord and Burdick Rept. on Flood Relief for the Scioto Valley, 1916, p. 62.

Maximum 72 Hours—Rainfall 7 a. m., Mar. 23 to 7 a. m., Mar. 26, 8.08-ins.; Run-off 6 p. m., Mar. 24, to 6 p. m., Mar. 27, 5.52-ins.; period between beginning of rainfall and beginning of run-off as above equals 35 hrs.; ratio run-off to rainfall (run-off coefficient), 68.2 percent.

Maximum 48 Hours—Rainfall 7 a. m., Mar. 23 to 7 a. m., Mar. 25, 6.4-ins.; run-off 6 a. m., Mar. 25 to 6 a. m., Mar. 27, 4.2-ins.; period between beginning of rainfall and beginning of run-off as above, 47 hours; ratio run-off to rainfall (run-off coefficient), 65.7 percent.

Maximum 24 Hours—Rainfall 6 a. m., Mar. 24 to 6 a. m., Mar. 25, 4.1-ins.; run-off 6 a. m., Mar. 25 to 6 a. m., Mar. 26, 2.4-ins.; period between beginning of rainfall and beginning of run-off as above, 24 hrs.; ratio run-off to rainfall (run-off coefficient), 58.6 percent.

The maximum rate of discharge at the Columbus dam (Mar. 25) was 79,000 c. f. s., equivalent to 74.3 c. f. s. per sq. mi. This rate was maintained for about 3 hrs. It is equivalent to 0.267-ins. depth over the watershed per hour, and is 238 percent of the average rate of rainfall for the maximum 72 hours (0.112-in. per hr.)

The storm occurred at a time when the flow in the river was very small, being about 450 c. f. s. There was no snow on the watershed, the ground was water-soaked and practically frozen, the rate of evaporation was low and conditions in general were especially well suited to produce a large run-off.

Run-off Coefficient

From the above figures it is evident that for a storm of the length and intensity of this one (9.34-ins. rain in 94 hours), and other conditions favorable, a run-off of at least 68 to 70 percent may reasonably be expected. If there had been no storage on the Scioto, the run-off would have been greater. It is interesting to note that for shorter periods of time the run-off coefficient is less.

Miami River Run-off

Data regarding the rainfall of the storm of March 23-27, 1913, on the Miami River, Ohio, drainage area and the resulting flood run-off are given in Mead's Hydrology, 1919, p. 568; Miami Conservancy District, Report of Chief Engineer, Vol. 1, 1916.

The average amount and rates of rainfall over the drainage area were computed from the observations at a number of sta-

tions in and near the watershed, apparently giving a very close estimate of the actual rainfall which caused the flood flow.

The run-off of the river was computed from an elaborate series of hydraulic measurements and computations based on the flood profile, river cross-sections and assumed coefficient of roughness as used in the Kutter formula and others. Corroborative results were obtained at a number of stations, which led the engineers of the Miami Conservancy District to believe that the computed discharge rates were reasonably accurate. It is doubtful if the records of run-off of the Miami are as accurate as those of the Scioto, due to the difference in conditions and possibilities of accurate measurement.

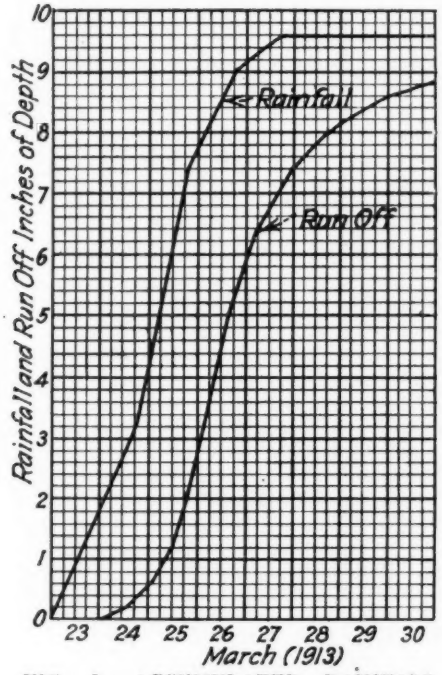


FIG 2. ACCUMULATED RAINFALL AND RUN-OFF ON THE MIAMI RIVER ABOVE DAYTON, OHIO.

Storm of March 23-27, 1913. Drainage of Miami River above Wolf Creek, 2,525 Sq. Miles.

Fig. 2 shows the accumulated rainfall on the Miami River watershed and the accumulated run-off of the river above Dayton.

The principal facts of interest are as follows:

Drainage Area of Miami River at Dayton above Wolf Creek, 2,525 sq. mi.

The country is generally rolling and is nearly all cleared for cultivation.

The average river channel capacity outside of cities and towns at the time of the flood was only about 9.5 percent of the flood discharge.

Dayton is located at the confluence of Mad, Stillwater and Miami Rivers and Wolf Creek.

The Miami River has a slope of 3 to 4 ft. per mile for a distance of 35 miles above Dayton, Mad River a slope of about 6 ft. per mile, Stillwater River a slope of about 4 ft. per mile and Wolf Creek a slope of 17.5 ft. per mile.

Rainfall on Miami Watershed (Mar. 23-27, 1913), in 116 hrs., more or less, 9.6-ins.

Run-off Miami River above Dayton (Mar. 24-30), in 168 hrs., more or less, 8.9-ins.

Ratio, 92.7 percent.

Rain began to fall about midnight, Mar. 22.

River began to rise about midnight, Mar. 23.

River began to rise rapidly about midnight, Mar. 24.

Period of concentration on river apparently about 48 hrs. at beginning of storm.

Maximum flood rate during the night of Mar. 25-26 and lasted for several hours.

Maximum 72 *Hours*—Rainfall midnight Mar. 22-midnight, Mar. 25, 7.9-ins.; run-off midnight, Mar. 24-midnight, Mar. 27, 7.2-ins.; ratio (run-off coefficient), 91 percent.

Maximum 48 *Hours*—Rainfall, 7 p. m., Mar. 23-7 p. m., Mar. 25, 6.1-ins.; run-off, midnight, Mar. 24-midnight, Mar. 26, 5.6-ins.; ratio (run-off coefficient), 91.8 percent.

Maximum 24 *Hours*—Rainfall, 7 p. m., Mar. 24-7 p. m., Mar. 25, 4.1-ins.; run-off, midnight, Mar. 25-midnight, Mar. 26, 3.1-ins.; ratio (run-off coefficient), 75.6 percent.

The conditions on the watershed at the time of the flood were substantially the same as described for the Scioto. There was no snow on the watershed, the ground was watersoaked and practically frozen, the rate of evaporation was low and conditions in general were especially well suited to produce a large run-off.

Run-off Coefficient

From the above figures, a run-off coefficient of 90 to 91 per cent. may be expected from a storm of the duration and intensity of that experienced on the Miami, with other conditions particularly favorable. The location of Dayton at the confluence of several large streams is thought to be one reason for the high rates of run-off. Also, the lack of storage on the watershed as compared with that

on the Scioto undoubtedly was another cause.

Sudbury River Run-off

A freshet in the Sudbury River in Massachusetts on February 10-13, 1886, is described by Fitzgerald in Trans. Am. Soc. C. E. Vol. 25, 1891, p. 253 et seq.

Drainage area Sudbury River at gaging point, about 75 sq. mi.

Drainage area Cold Spring Brook at gaging point, about 6.4 sq. mi.

Cold Spring Brook drainage area is included in the Sudbury. The latter has about 38 per cent. of its surface covered with woods.

Rainfall in 3 days including 2 ins. of melted snow, 6.7-ins.

Run-off of Sudbury River in 8 days, 5.1-ins.

Run-off of Cold Spring Brook in 8 days, 5.4-ins.

Ratio run-off to rainfall, Sudbury River, 76.1 percent.

Ratio run-off to rainfall, Cold Spring Brook, 80.6 percent.

Note that these ratios relate to the total run-off of 8 days compared to the rainfall in 3 days, and are not properly called run-off coefficients.

There was considerable snow and ice on the ground at the beginning of the rain. Some of the rain as it fell was absorbed by the snow. About three-quarters of the snow went off with the rain and the remaining portion followed a few days later. The ground was frozen at the time.

Cameron Creek Run-off

A flood on Cameron Creek near Hurley, New Mexico, is described in Water Supply Paper No. 358, p. 662-3.

Drainage area above gaging station, 4.4 sq. mi.

Average rainfall on watershed, Aug. 10, to 14, 1913, 2.34-in.

Equivalent to 5,490 acre-ft (mostly on August 14).

The flood reached the gaging station at 3.20 p. m., August 14 with a discharge of 2,300 sec. ft. The stream continued to rise until 4.25 p. m. on the 14th, the maximum discharge being 5,490 sec. ft.

It then began to recede and at 3 a. m. on the 15th ceased to flow.

Duration of discharge, 12 hrs.; mean discharge, 1,370 sec. ft.; volume discharged, 1,360 acre-ft., equivalent to 25 per cent. of the rainfall on the drainage area.

"This low percentage run-off is attributed in large measure to the preceding period of drought, the general condition of the drainage area, and the high rate of evaporation."

This record is of interest as indicating the extent to which a dry porous soil can absorb rain and prevent a high rate of run-off.

Conclusions

Careful study of the foregoing evidence seems to indicate that in estimating rates of flood flow for which provision should be made in works for preventing flood damages, a run-off coefficient of 0.80 should be employed in cases where the earth is moderately impervious or the slopes fairly steep. This probably represents the proportion of the rainfall rate likely to be realized in floods of somewhat rare occurrence—say once in 25 to 100 years.

Under extreme conditions, the kind which would be accepted by the courts as "Acts of God," which may perhaps occur at intervals of from 100 to 1,000 years, it is probable that a higher rate of run-off will be attained, and for estimating flood flows which controlling works such as spillways must be able to withstand with safety, a run-off coefficient not less than 0.90 should probably be assumed, and this, of course, would be applied to the higher rainfall rate which would obtain under these extreme conditions.

CONTRACT FORMS

By George W. Tillson, Consulting Engineer, 313 S. Catherine Ave., La Grange, Ill.

(Editor's Note: In presenting the following paper before the 1921 meeting of the Illinois Engineering Society, Mr. Tillson made no attempt to discuss the forms of contracts recently adopted in some places where the prices for the work vary in accordance with the prices of labor and material. He feels that conditions will soon be back to normal so that these new forms will not be required; also that they will be used mainly for large contracts extending over a long period, and that in any event most of the ideas here presented will be adaptable to the modified forms.)

Practically all corporations, whether public or private, as well as many individuals, have their construction work performed according to a formal contract. It is important, therefore, that such an instrument should be drawn up with greatest care.

The document that is commonly called the contract should be made up of three separate and distinct parts, each independent of each other, but the three com-

bining to form the contract itself. These three parts are known as Instructions to Bidders and Form of Proposal, Plans and Specifications, and Form of Agreement. Now, while these parts are independent of each other, they must be so worded as not to be in actual or apparent conflict. As the three make up one whole that must be treated as a whole; this point is exceedingly important.

Great care should also be used to see that the items to be covered are always placed in the proper part. This is not difficult if the questions are given proper attention.

The object of drawing up all documents before bids are asked is to give the bidders all the information possible about the work, both as to quantity and character, and to tell them what obligations the successful one must enter into and to inform the corporation just what it may expect as to character of work, time of completion and amount of payment.

Instructions to Bidders and Form of Proposal

In these days it is considered the best policy when advertising for proposals for any kind of work to furnish the fullest information possible regarding it. How difficult this will be depends, of course, upon the character of the work itself. Road work, for instance, does not require as much preliminary investigation as a sewer job, while such contracts as were awarded by the Board of Water Supply of the City of New York, during the last 15 years, required a vast amount. Any corporation asking for bids wants as much competition as possible. To make intelligent bids men must know all the conditions under which the work must be carried out. If the corporation itself makes all the necessary investigations, it can furnish the information to all prospective bidders, in this way often inducing people to bid who otherwise might not think it worth while to investigate for themselves. Then, too, in any event, a certain amount of work must be done in order to prepare plans and information for any kind of bidding and the extra cost of making everything complete will generally not be excessive. Of course, such information must be accurate, otherwise much controversy and often litigation will arise if in carrying out his contract the successful bidder should find conditions varying materially from those shown when he made his bid. This is one of the main arguments used against the corporation attempting to furnish all preliminary information about character of ground, for instance, and conditions under which the work must be performed.

Bids should be received by items, a positive and specific price made for each so that a slight variation in quantities will not matter. If an amount of rock is to be excavated and the approximate amount is not known, a contractor cannot figure as to its exact cost. He may take a chance on it being small and bid very high or very low with the idea that in either case it will not materially affect his bid. But should the quantity prove to be large he may receive an excessive amount, or, on the other hand, be obliged to do the work at considerable loss.

In the case of a sewer contract, if an attempt be made to show the amount or locality of water to be encountered, great care should be exercised, as the water line may change appreciably between the time of making the survey and the carrying out of the work. If water is shown to exist anywhere on the line of the work, a note should be made in a conspicuous place stating that these conditions existed on a certain date, and it is not known that they are permanent. Attention should be called to other than physical conditions, if any exist.

If other than cash is to be paid for the work, it should be stated in just what form the payments will be made. If the work is to be guaranteed for a term of years, or any legal conditions are to be observed, it should be plainly set forth.

If any guarantee is required on any part of the work, it should be so stated. Also, if any deposit is required with the bid or bond for the carrying out of the work.

Proposals

Blank forms for proposals should always be prepared, so that all bids will be made on the same basis, and so, easily and accurately compared. Any variation from the prepared form should render the bid informal and cause it to be thrown out. A statement to this effect should be made in the instructions to bidders.

These forms should be made out carefully and in connection with the specifications and agreement so that there may be no conflict between either. The writer has in mind a contract for sewer construction where the proposal stated that the price bid included the cost of protecting any and all railroad tracks that the sewer passed under. In the agreement there was a clause that said the

contractor should allow the railroad company every facility for protecting its track. The proposal plainly stated that the contractor was to protect the tracks while the agreement as plainly intimated that this work was to be done by the railroad.

The contractor saw the point and insisted that he should be reimbursed for his alleged extra work. The Board of Public Works at first laughed at the idea, but when asked what the clause in the agreement did mean if it did not mean the railroad company would do the work, and being unable to answer, finally allowed the contractor one-half of the cost of the work. As a matter of fact, the proposals should not contain conditions. These should all be in the agreement.

In the above case, if prices had been given simply for constructing certain sizes of sewers, and a clause in the agreement had stated that wherever the sewers passed under any railroad tracks, the cost of protecting the tracks should be borne by the contractor, there would have been no controversy.

Specifications

The object of the specifications is to tell the contractor the character of the materials he must furnish and how the work must be performed. This should be done clearly, definitely and concisely. Nothing should be described generally. Expressions like "equal to," "as good as" should not be used. The properties of the article should be described. The whole theory of competitive bids is equality; that each bidder should have the same information.

Before an advertisement for proposals for public work can be published in New York City, the proposed contract and advertisement must be approved by an assistant corporation counsel especially designated for that purpose. He takes the stand that the engineer should know what he wants and ask for it. And it would seem as if he were right. He objects to generalization or the naming of specific kinds of articles. Such as a certain brand of paint, or certain make of a lock, the idea being to say just what is wanted and then let the manufacturers work accordingly.

The person who draws up the specifications should have such a knowledge of materials or work required so as not to make too stringent requirements, and not to call for dimensions that are not generally manufactured unless it is absolutely necessary. It is a simple matter to specify what might be difficult and expensive to make up. If standard forms and shapes can be used, they should always be called for. A few years ago the cities of Boston, New York and Philadelphia used granite paving blocks of such dimensions that the blocks of one city could not be used in either of the others, though practically just as good. So each quarry had to know what city it was making blocks for and a shortage in one city could not be made up by a possible surplus in another.

Then, too, in making specifications for material that is to be used from year to year, such as paving brick, granite or wood paving blocks, asphalt, cement, or anything of this character, the manufacturers should be consulted with, so that unnecessary conditions may not be imposed. By doing this the co-operation of the manufacturers is secured, and this is always to be desired.

The old idea that an agreement between, or consultation with the engineers on the one side and the contractors and manufacturers on the other, means collusion and fraud, is exploded, as it is generally recognized that only by a full and complete co-operation can work be performed most cheaply and efficiently.

From what has been said it should be easy to determine what should be put in the specifications and what should not. But variations from these ideas are very common.

The writer some time ago was called upon to investigate a newly laid pavement. The question arose as to length of guarantee, if any. A careful study of the agreement failed to find any such provision whatever. But when looking over the entire document it was learned that the specifications called for a guarantee of five years. This certainly was an item for the agreement. Care should be taken so as not to insert in the specifications any requirements that are not to be enforced. Otherwise the cost of the work may be increased or a contractor knowing the customs and usages of a locality may be able unfairly to defeat a bidder coming from the outside.

Leave as little as possible to the judgment of the engineer, architect, or whoever may be in charge of the construction. The writer knows that many people will say "Oh! that does not amount to anything—no court will sustain that." But they are wrong. In the first place there is no desire to get into court, and in the second place there are many instances where the court has ruled that where the contract says that the decision of the engineer shall be final, or that certain things

must be done when ordered by the engineer, the contract binds and its provisions must be fully carried out.

Plans

The plans of any work show the character and location of the structure, dimensions of details so that the bidder can tell just what he is expected to construct. Although bearing the same relation to the contract as the specifications, it differs from them in showing what is to be built rather than how.

The plans should be full and complete, all details being drawn to such a scale that they can be easily understood. As they form so important a part of the contract, on any work of much magnitude they should be signed by the contractor, so that in case of a dispute there can be no question what particular plans are referred to. This is important as in many instances the plans are so large that they cannot be bound with the contract.

Care must be taken to see that all notes made on the plans are strictly in accordance with the specifications, instructions to bidders and form of proposal. While this is a simple and unquestionable proposition, and it may seem that too much stress is laid upon it for that reason, much confusion and litigation have often arisen because there is so often a difference in the requirements of these different parts.

Agreement

The agreement is practically the summation of all papers. The contractor knows what he is expected to do, and the corporation knows what it is expected to pay for the same. The agreement fixes the conditions under which the work is to be performed, and when signed by both parties, binds them both to carrying it out.

It should provide that the instruction to bidders, form of proposals, plans, specifications and the agreement, all taken together, should form the contract the provisions of all of which the contractor is bound to carry out. It should state clearly who is to have responsible charge of the work and who is to decide disputes, should any arise. It should also state how and upon what individual formal notices to the contractor should be served. It should also provide for the cancellation of the contract in case the contractor failed to carry out its provisions, and in such event what penalty should be imposed. It should state just when partial payments are to be made, if any, and of what amount, also time and conditions of final payment.

If the work or any part of it is to be guaranteed for any particular time, this should be clearly stated.

It should specify the time of beginning the work, time allowed for its completion, and penalty, if any, if it is not finished within the required time.

In this paper no attempt is made to include all the provisions that should be inserted in an agreement, or other parts of the contract, but it is hoped to show their character so that whatever item it is desired to insert in a contract shall be placed in its proper place in order that the contract as a whole shall be entirely logical and one that can be enforced in the courts, if necessary.

In looking over the contracts of different municipalities, for instance, one is surprised at the different forms used and the variation in details. Much variation, of course, is caused by the difference in the laws governing the cities, but much of it is due to the lack of attention given to details.

In New York City, where public contracts have been given out for over a century, the present forms are very voluminous and are the results of experience. It is said that when, for instance, a contractor sues the city upon any particular clause of the contract and recovers damages, the legal department either changes that clause or adds another to meet the objections of the court. When one reflects that this has been going on for a hundred years, with very many thousands of contracts, it is not strange that the present forms are so lengthy.

While a contract should be clear and explicit so as to be fair to both parties, it should also be as concise as posible and provide for the rights of the corporation and the contractor.

Bond

The contractor is required to give a bond for the faithful performance of his contract. The amount varies with character and size of the contract. Its form is simple as it simply binds the contractor to do what he says he will do. It does not go into details, but refers to the contract, and this is one of the reasons why all the parts making up the contract should be clear and consistent with each other.

A bond is a highly technical document, and to enforce it the legal provisions of the contract must have been carried out.

It is not a part of the contract as it is not signed by both parties. It obligates a bondsman to pay to the corpora-

tion a certain sum if the contractor fails to live up to his undertaking.

Summary

In closing the writer wants to sum up briefly, even to the point of repetition, what he feels are the important things to be considered.

Make all conditions, physical or legal, clear and plain, so that prospective bidders will make their prices on the same basis, and on the same printed forms.

Let the plans and specifications show location and amount of work, character of materials, and just how the materials are to be used.

Let the agreement contain all the conditions by which both parties to it are to be held and bind up these different parts into one controlling and complete instrument to be known as the contract.

THE TREND OF ENGINEERING SPECIALIZATION

By Wm. E. Vogelback, of the Sanderson & Porter Engineering Staff, 72 W. Adams St., Chicago, Ill.

The study of industry is a study of organization. After many years of systematic grouping and arrangement of activities, we find business emerging in the last decade as one of the major professions, subdivided into a multitude of minor professions. Each of these minor professions, such as advertising, credit, management and salesmanship, has become a highly specialized science. Other major professions, particularly engineering, have followed this same trend of specialization. A century ago a man in any branch of the engineering profession was identified simply as an engineer. Fifty years ago he was a civil or mechanical or electrical engineer, while today these latter terms give but a vague idea of his qualifications or his occupation. Specialization finds its way into all industries and professions, subdividing single occupations into many, and confining the individual more and more to specific tasks. Men have learned to anticipate the trend of events, and, therefore, we find a profession, as engineering, for example, crowded with men of but limited training, and capable of but minor specific tasks.

There is an evil here to the detriment of the individual as well as to the profession. As it is, the world needs men of vision—men who are capable of big things—men who are scientists. Comparatively few men are scientists in the broader application of this term. Few men are possessed of the ability to analyze complete problems; to see the relation between the problem in its entirety and any or all of its component factors. The individual minds of the great majority work synthetically. They grasp only that particular phase of a problem which comes under the immediate observation; one factor at a time without regard for the relation of that factor to the sum total.

Specialization does not assist in turning out these scientists—these leaders of men—but on the contrary, materially assists in their suppression, and hence we must look elsewhere for the forces which tend to preserve this balance.

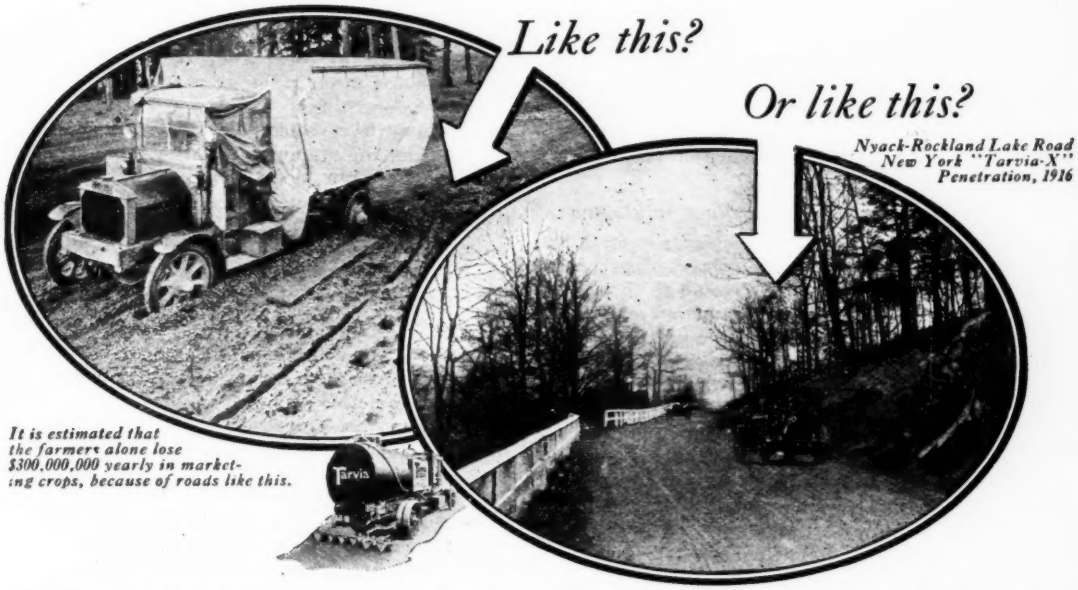
Educational Institutions and Professional Societies

These forces will be found in our educational institutions and our professional societies. Here, stringent requirements should be fulfilled and ethical standards should be maintained. But of these two, the greater responsibility rests upon our educational institutions. The measure of proficiency of a college is not what studies are embodied in its curriculum, but what the average student learns, which will be of advantage to him in the years which are to follow.

Analytical and Synthetical Thinkers

In the short space of the usual college course today it is not expected that colleges will turn out men fully equipped for their professional practice. The aim should rather be to inculcate a method of logical reasoning, to turn out *analytical* thinkers—scientists. But I feel sure that you will agree with me that too many men just out of college come better equipped with a collection of facts than with methods of analysis. In other words, we are turning out *synthetical* thinkers—men whose measure of comprehension of a subject is the quantity of facts they possess. I desire to emphasize this distinction between analytical and synthetical thinkers. Every individual belongs to one or the other of these classes. The class of synthetical thinkers comprises the rank and file, the detail workers, the narrow specialists. The class of analytical thinkers comprises the executives, the leaders, the planners, men of vision and foresight.

The degree of our analysis of any subject depends upon the interest we have in it. And our interest will depend upon our comprehension of the subject as a whole. If we reflect back upon those subjects in which we were most proficient in school, we will find that they were the



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ones in which we had the greatest interest. And probably we all recall our attitudes toward those subjects which we then seemingly knew we would never have occasion to put to practical use. Interest in a subject is more easily obtained by a preliminary survey of the subject to be studied.

Early Training of Successful Men

Take our large cities, centers of industry, with their vast day and night educational opportunities. Would it not appear that the great majority of our successful men should be those brought up under these educational advantages? And yet as we run through the pages of "Who's Who" we observe in page after page the names of men whose education was acquired in the village school house, or small town college, or by home study. I believe these incidents are relevant and important, and that they are a natural result of a well-defined cause. This cause is the greater ratio of practical learning to the degree of specialization. In the smaller towns, industry is centralized and extensive specialization is not expedient. Here the young man entering business sees the small shoe manufacturing industry or the rice industry in its entirety. He sees the relation between the different departments and the whole plant. With the whole mechanism under one roof, so to speak, his view is comprehensive. This is impossible in the industries in our larger cities. Here specialization has reduced the work of the individual to a mere routine. He fails to see the relation of his job to the industry. In time perhaps he will have held many jobs, but he will always be working under the disadvantage of lack of comprehension.

Evil Effects of Specialization

After a man has completed his college training the evil effects of specialization, as applied to him, must be stemmed by the professional organizations. Here, by his association with other men in the same general profession, he extends his interests into broader fields. Perhaps the most beneficial work that can be done by a professional society is that of maintaining appropriate standards of ethics and qualifications for membership. Here, too, is charged a large share of activity in securing appropriate license legislation. Limited preparation for the professions should be discouraged.

The big problem of today is how are we going to keep the synthetical class from growing greater in proportion to the analytical class. We see how specialization tends to confine more and more the individual to routine duties; to make of him a mere cog in the great wheel of industry. The remedy calls for a greater interest in our undertakings. The larger business institutions have come to regard this interest from the standpoint of the individual's partnership in the business. They have evolved the medium of employes' organizations and house organs for educational purposes. In this way they have been able to maintain a partial balance between specialization and training.

Controlling Trend of Specialization

In the profession of engineering the individuals must have recourse to their professional societies and we find such organizations as the American Association of Engineers fulfilling an urgent demand and materially assisting in preserving the balance. Nevertheless this profession is crowded with men who have spent but a few months in some school, preparing themselves for the position of estimators, computers, draftsmen, etc., and yet with this limited training assume the professional title of engineer. This accounts in a large degree for the growing disparity of remuneration between engineering and other professions or occupations.

There is but little activity in the world that does not require engineering. Next to law, engineering should find a leading place in national government, but not until our educational institutions, our professional societies and our individuals recognize and control this trend of specialization, instead of being controlled by it, will engineering find its place and proper standing, and attain its leadership in world affairs in general.

The foregoing address by Mr. Vogelback was delivered at the Conference on Employment and Vocational Education held at Chicago, November 12, 1920, sponsored by the American Association of Engineers.

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WATER WORKS SECTION

SAN FRANCISCO'S FAILURE TO ACQUIRE THE SPRING VALLEY WATER WORKS

By C. E. Grunsky, Consulting Engineer, 57 Post St., San Francisco, Calif.

The proposition to acquire the Spring Valley Water Works was recently submitted to the voters of San Francisco for the third time and was defeated. A two-thirds vote would have been required to carry this proposition. San Francisco will continue, therefore, for some time longer to be the only city of first magnitude in the United States which does not own the water works by which water is supplied to the inhabitants.

The Property in Question.

It had been agreed in this case to let the city engineer select and designate the items of the plant, including lands in watersheds and lands of value as water producing areas, which the city should acquire, and to let the state railroad commission fix the price at which the deal was to be consummated. The property included a distributing system, pipes, service reservoirs and pumping stations which had grown with the city. It included the three storage reservoirs on the peninsula south of San Francisco, the Pilarcitos with a capacity of 1,000,000,000 gals., the San Andres with a capacity of 5,000,000,000 gals., and the Crystal Springs with a capacity of 23,500,000,000 gals., the latter storage capable of increase by raising the dam to about 42,000,000,000 gals. The property also included the company's water developments on Alameda Creek, from which source about one-half of the Spring Valley Water Company's water is at present obtained. Some 61,000 acres of land mainly in the watersheds tributary to the storage reservoirs were included among the property which the city could have acquired.

The Water Supply Problem

It is well known that the agitation for public ownership on both sides of San Francisco Bay has made it difficult for the private interests which controlled the development of the nearby water sources to effect this development at a rate in keeping with the growth and potential requirements of the rapidly increasing population. It is also well known that the local sources of water must, within a comparatively short time be supplemented by the bringing of water from some suitable remote source. The people on both sides of the bay have, heretofore, been in much uncertainty as to the adequacy of the water supply from local sources. There is no adequate living stream within easy reach. Dependence has had to be placed on storage and the peculiarities of the California climate are such that storage means not alone the bridging of the annual period when the local streams are dry, due to the long rainless period of summer, but, also the holding over of water from one season of copious rains and ample runoff to meet the deficiency of possibly two years in succession of materially less than normal rain. Where dependence is placed on surface runoff alone from coast range areas near San Francisco, the conclusion was early reached that, to be fairly safe, the storage reservoir should have a capacity equal to a 900 days' supply. This may seem excessive to those who are only familiar with conditions on the Atlantic slope; but the wisdom of this provision has been repeatedly demonstrated in the case of San Francisco.

The city has now for over 30 years been obtaining a portion of its water from the east side of San Francisco Bay. Subsurface sources have there been made use of to a considerable extent. The surface storage on the Peninsula has thus been materially supplemented by underground storage on the other side of the bay. Furthermore, the project of increasing the water output of the east bay sources is well under way. The water of Calaveras Creek, a main tributary of Alameda Creek, will be held back in a reservoir, which is already in service at part capacity. The water works taken in their entirety are a going concern which have grown and have been expanded as the city has grown. They are supplying to the city an average daily amount of water somewhere between 35,000,000 gals. and 40,000,000 gals.

Recommendation Made in 1902

The writer, as city engineer of San Francisco in 1902, in reporting upon a water supply project for San Francisco with Tuolumne River as the source of supply made the following statement:

"This project is submitted in compliance with directions of the Board of Public Works, as authorized by the Board of Supervisors under charter requirement. It is not to be inferred, however, that the city engineer desires to recommend in submitting this report and a cost estimate, the original construction of an entirely independent water works system as here outlined * * * No other conclusion can be reached than that the interests of the city and of the Spring Valley Water Works are mutual—to have the established works in part, at least, retained in service and to have the new works supplement that part of the Spring Valley Water Works system which can be retained in use."

First Step Toward Acquistion in 1909

Despite this advice no serious steps were taken for the acquisition of the Spring Valley Water Works until 1909. The proposition then formulated to buy at a price of $35,000,000 all properties then owned by the water company without reservation, was defeated early in 1910 by a narrow margin. Four years later, under reservation by the water company of various items, more especially a large tract of land within and closely adjoining San Francisco, the second proposition to sell, this time at $34,500,000 was again turned down by the electors.

Why People Voted Against Project

The question arises as to the underlying causes of the recent refusal on the part of the people to do what is so obviously desirable. Perhaps the reason is to be sought primarily in the impression that the Tuolumne River project is being built and will soon make high quality Sierra Nevada water available. There have been $45,000,000 voted for this project, and more than one half of this sum is being expended in the construction of the Hetch Hetchy dam and diversion works, conduits and tunnels and power plants, which will, however, leave the water still in Tuolumne River in the the foothills of the Sierra Nevada, east of the San Joaquin Valley and more than 100 miles by proposed conduit route from San Francisco.

There seems to be still a considerable proportion of the people of the city who do not understand that it would be an economic waste to duplicate the distributing system now in service and that even if such duplication were decided upon that the city would still be in need of of the near-by storage facilities now owned by the Spring Valley Water Company, and which can not be dispensed with as a part of a satisfactory system, as no equivalent substitutional storage sites exist on the peninsula. Then, again, the congressional action under which reservoir and other rights of way for the Tuolumne River project were granted to San Francisco is not understood by every one. In some quarters the fear has been expressed that if the city acquired the Spring Valley Water Works there would be more delay in bringing the Sierra Nevada water into the city than if these water works continued to be privately owned. The restrictions imposed by congressional action in this matter are onerous and may long delay the bringing to San Francisco of Sierra Nevada water. They are in effect that, before Sierra Nevada water is carried beyond the limits of the San Joaquin Valley, the near-by sources of water supply must first be fully developed. The exact words of the inhibition are:

"That said grantee (city of San Francisco) shall not divert beyond the limits of the San Joaquin Valley any more of the waters of the Tuolumne watershed than, together with the waters which it now has or may hereafter acquire, shall be necessary for its beneficial use for domestic and other municipal purposes."

The question may well arise in view of this language whether this restriction applies as is generally believed to be intended, if the near-by sources of supply are privately as well as if municipally owned.

Price Not Approved.

The price, too, at which the water works were to be purchased did not meet with universal approval and there always remained some uncertainty as to the dependable quantity of water that a purchase of the water works would place at the disposal of the city. It is only necessary, in this connection, to quote from the pamphlet entitled, "Facts, Figures, Arguments," prepared and distributed by the Campaign Committee of the administration for use in the recent campaign. We read in this pamphlet:

"The city is to acquire the right to pump not exceeding 15,000,000 gals. daily of water as against the lands retained at Pleasanton by the Spring Valley Water Company. This right is in excess of any

amount of water which has heretofore been pumped from that source. The company agrees not to interfere with this right except that it may take such water as is necessary for irrigating the retained lands, but nothing further."

The Pleasanton ranch lands which the water company was to retain and for which it is inferred that water was thus reserved, have an area of 4,730 acres. It is readily conceivable that during the irrigation period of 6 or 7 months, from April to October, the aggregate amount of water applied to these lands, when brought under intense cultivation, will be equivalent to about 24 ins. over all. This would represent an average draft of 14,000,000 to 15,000,000 gals. per day for 6 or 7 months of each year upon the same Pleasanton sub-surface sources from which the city would be drawing water. The writer has failed to find anything in the pamphlet that would show that against this irrigation draft there is any protection assured to the city. This fact is cited merely to show that despite the thoroughly organized campaign conducted by the city administration for the proposition, it was not made clear what the city was to get and this, as a matter of course, threw more or less doubt upon the fairness of the price.

Finally, as in all such propositions, under which new responsibilities are placed upon the municipal government, there were no doubt some who were swayed by lack of confidence in the present administration. The intensiveness of the campaign conducted by the city officials could only heighten distrust where distrust already existed and it did not succeed in bringing out a large enough vote to offset the effectiveness of a determined, though very quiet, opposition.

Despite the result of the recent vote the question of San Francisco's acquiring the Spring Valley Water Works by purchase must again come up and will continue to come up until the city owns these properties. The writer still holds the view to which he gave official expression in 1902—as above quoted—that the interests of the city and of the Spring Valley Water Company in so far as the acquisition of the water works properties by the city is concerned are mutual. He believes, furthermore, that if all affairs relating to municipally owned water works were entrusted to a properly constituted Water Board—the lack of which has long been felt—that a recommendation by such a board would go far toward quieting opposition.

IMPOUNDED WATER AT BLOOMINGTON, IND.

By Donald H. Maxwell, Assistant Engineer, Alvord & Burdick, Hydraulic and Sanitary Engineers, Hartford Bldg., Chicago

Bloomington is located on the summit of the divide between the east and west forks of White River, in the driftless area of southern Indiana. A ground water supply is not available. The topography is rugged and good reservoir sites for an impounded supply are apparently plentiful on the contour map. Unfortunately the impounded supply that has actually been developed by the city has been unsatisfactory and inefficient. To appreciate one of the serious defects in the existing impounded supply, and the possibility of a satisfactory reservoir supply, it is necessary to consider the geological structure in this vicinity.

Geological Structure

The rock formations at Bloomington are stratified and dip gently to the west southwest, so that the successive outcrops form north and south strips from ¼ mile to 4 miles wide, their lines of contact made very irregular by surface erosion. The lowest formation exposed in the vicinity of Bloomington is the Knobstone, consisting of dense sandstones and shales several hundred feet in thickness, which appear in the bottoms and sides of the valleys to the north, east and southeast of the city. Above this lies the Harrodsburg limestone which outcrops on the uplands north, south and east of Bloomington, and in the lower portions of the city. Immediately above this formation occurs a stratum about 60 ft. thick of Bedford limestone, which underlies the surface in the higher portions of Bloomington, and outcrops along the sides of ravines to the north and south of the city. Next above the Bedford limestone lies the Mitchell limestone, which outcrops over an area about four miles in width, extending west from Bloomington. It is in this latter formation that the present city water supply has been developed. The rocks of this whole region are overlaid on the uplands by a thin, rather impervious soil cover and the alluvial deposits in the valleys are shallow.

The sandstones and shales of the Knobstone are unusually impervious and tough, but resist weathering very poorly, and are deeply eroded where exposed. The limestones are in general soluble and are honeycombed with solution channels. This is particularly true of the upper strata of the Mitchell formation.

The geological conditions are in general distinctly adverse to the development of an underground water supply for a city as large as Bloomington, which has a present population of 12,000. In fact good wells for domestic water supply are infrequent.

The influence of the rocks is evident in the varying topography around Bloomington. To the west in the central portion of the Mitchell limestone outcrop, the uplands are rolling, and pitted with sink holes. The water courses are shallow and often disappear into the cavernous limestone to isue later as springs at the contact plane with less soluble rocks below. Eastward toward the edge of the Mitchell limestone outcrop and beyond, the topography is rough and the streams deeply eroded in the lower limestones, and in the sandstone and shales of the Knobstone formation. The topography in this area offers numerous reservoir sites, but on account of the varying character of the rock formations, they are not all equally desirable from the standpoint of watertightness. This has been demonstrated by local experience.

Present Impounded Supply

The two older city reservoirs are located entirely in the cavernous Mitchell limestone formation. The dam of the newer Leonard Springs reservoir rests on Bedford limestone, while the upper part of the reservoir is in the Mitchell limestone.

The experience with these three city reservoirs has demonstrated that a watertight reservoir should not be expected in these limestone formations, particularly in the Mitchell limestone. At the old reservoirs leakage occurs in solution channels through which the water finds its way around the dams, and under the spillways in natural rock to such an extent that several years ago the entire city water supply was taken from a spring or leak below the lower dam at the main pumping station. When the reservoirs are not full, water not pumped to the city is pumped back into the reservoirs to help conserve the supply. At the newer Leonard Springs reservoir, there is a large marsh immediately in front of the dam, with indications of a considerable flow of water from the reservoir above. The leakage from these reservoirs is so great that even though all unused visible leakage is pumped back into the upper reservoirs, they become rapidly depleted in dry weather. Efforts to correct the leakage have been unsuccessful.

Advantages of Knobstone Area

Satisfactory reservoir sites are available in the creek valleys east and north of Bloomington at no greater distance than the existing city reservoirs built in the Mitchell limestone area. In these creeks the Knobstone formation provides an impervious basin which is ideal for retaining an impounded supply, and the narrow deeply trenched valleys afford numerous good dam sites.

In striking contrast to the city reservoirs in the limestone is the very succesful reservoir built in the Knobstone formation by the Indiana University for its own water supply. This reservoir was located on the recommendation of Prof. E. R. Cumings, geologist at the university.

The reservoir is formed by a concrete arched dam 40 ft. in height at the mouth of a small ravine entering Griffys Creek, and has a watershed of about 200 acres. This reservoir is absolutely tight and clearly shows that the city of Bloomington could obtain equally satisfactory reservoirs by utilizing the available reservoir sites in this formation instead of those in the limestones to the west.

The relation of the geology to the water supply of this region has been very fully described in a paper by Professor Cumings. The conclusions of Professor Cumings are reiterated by the report on the city water supply, made by Morris Knowles in 1914, which included a report on the local geology by Prof. W. O. Crosby, the geologist. Professor Crosby pointed out the defects on the Mitchell limestone for an impounded supply, and recommended that the city supply be developed in the impervious Knobstone formation.

The new Leonard Springs reservoir was built in the limestone formation subsequent to these recommendations. As above pointed out this reservoir has repeated the experience with the old reservoirs in the limestone, and Bloomington is again confronted with serious water shortage. The firm of Alvord & Burdick reported on the water supply in 1920, and recommended that the city abandon the reservoirs in the limestone area in favor of an adequate impounded supply in the Knobstone formation.

Deficiency in Present Supply.

Even if the impounding reservoirs of the Bloomington municipal supply were free from leakage, there is good reason to believe that the present development would be insufficient fully to supply the city during years of greatest drought. There are no records of the local water-

shed yield, but for the purpose of judging the adequacy of the existing development at Bloomington, comparison may be made with the long record of watershed yield at Lexington, Ky.

This latter record covers a period of 26 consecutive years. It is interesting to observe in this record the importance of a long record in determining the safe yield of a watershed, that is, the yield which may be depended upon in the year of greatest drought. If we consider the yield of the driest year in the 26 years' record at Lexington as 100%, the safe yield, as indicated by shorter records which did not include the driest years, would be as follows in percentage of the safe yield for the entire 26 year period:

	Per cent.
Driest year in 26 yrs.....	100
Second driest year, once in 18 yrs....	120
Third driest year, once in 15 yrs.....	125
Fourth driest year, once in 11 yrs....	160

It is apparent from these figures that the application of a short record of yield in developing an impounded supply may lead to a very serious overestimate of the safe yield.

At Bloomington the estimated safe yield of the city's impounded supply, based on the Lexington experience, is approximately one million gallons per day, as compared to a present average pumpage rate of about 1.5 million gallons per day. It is evident from this that the existing impounded supply at Bloomington is insufficient to provide the city with water throughout the driest year that may be expected. The deficiency might be as much as 60%.

The frequent water shortages experienced at Bloomington are due in part to the fact above pointed out that the development is deficient in safe yield. This deficiency is made more serious by the excessive leakage from improperly located reservoirs.

This paper by Mr. Maxwell was presented at the recent joint meeting of the Iowa and Illinois sections of the American Water Works Associations.

WATER PURIFICATION AT WHITING, INDIANA

By Samuel A. Greeley, of Pearse, Greeley & Hansen, Consulting Engineers, 39 West Adams St., Chicago, Ill.

The communities in the industrial district of northern Indiana, extending from South Chicago on the north to Gary on the southeast, depend upon Lake Michigan for their public water supplies. The population of this district numbers close to 200,000. The domestic or sanitary sewage which is cared for by the public sewers is being gradually diverted from the lake and with the completion of the Calumet-Sag Chanel and it conecting sewerage works, in 1921, it will be only at very rare intervals that domestic sewage from public sewers reaches the waters of Lake Michigan. At present only one small district, Robertsdale, sewers into the lake.

Industrial Sewage

There is, however, an immense volume of industrial sewage discharged into the lake, estimated roughly at well over 100 million gals. per 24 hours, and including with it some sanitary or domestic sewage from plant toilets. The industries are varied from cement mills to chemical works, but are predominantly oil and metal industries. Both of these industries produce considerable volumes of coal tar and petroleum wastes which impart tastes to the water supplies of most perisistent character. Under the war impetus, there was a marked increase of industrial capacity with larger volumes of sewage reaching the lake.

Whiting Conditions

Our first active conection with the water supply of Whiting was in the fall of 1916, or about 5 years ago. We had, however, studied the entire district for sewage treatment as far back as 1912. At both times (1912 and 1916) there was a pronounced petroleum flavor to the Whiting water supply but, so far as we know, similar complaints were not made of the water supplies of Hammond, East Chicago and Gary. At the present time tarry tastes occur in the East Chicago supply and probably occasionally in those of Hammond and Gary. There appears, therefore, to be an increasing and changing industrial sewage pollution.

The Whiting Testing Station

Because of the persistent petroleum flavor at Whiting and the lack of sufficient data upon which to base the design of a plant to treat such water, the construction of a small testing station was advised. The station was built and operated to determine (1) the effect of aeration on the taste; (2) the action of chemicals and coagulation upon the taste, and (3) general data reflecting the effect of the oil in the water upon the usual ratings of rapid water filtration plants. The tests covered a period of about 3 months during the summer of 1917. The only means of determining the residual flavor of the filtered water was by actual taste and

three independent series of observations were made by: (1) Pearse and Greely; (2) the Columbus Laboratories, and (3) the laboratory of the Standard Oil Company. The observers agreed upon a substantial removal of the petroleum flavor.

The Filter Plant

The design for the filtration plant at Whiting combines all of the requirements which the operation of the testing saation showed were essential.

The principal elements are, an aerator, a mixing basin, two coagulating basins, six filters, a filtered water basin, and the head house.

The capacity of the plant, based upon the filters, is 4,000,000 gals, per 24 hours. Provisions for enlargement are also made.

Water is supplied from the pumping station at the Standard Oil Company, about ½ mile distant, to the aerator, from which it flows by gravity through the plant to the filtered water storage basin. From there it is pumped by high service pumps into the mains.

The Aerator

The aerator is located on top of the coagulation basin roof. Structurally, it is a basin 30 ft. by 48 ft., in plan, surrounded by a concrete wall 3 ft. 6 ins. high, with vertically grooved columns on top for inserting stop planks between to confine the spray. The bottom of the aerating basin is stepped to a central collecting basin. Two 14-in. cast iron pipes, 8 ft. apart, lie on the floor of this basin and are tapped on 3-ft. centers for 22 No. 13A Spraco nozzles. The spray is directed, not vertically, but slightly inclined so that the two rows of sprays will collide. The spray in falling cascades down a few steps to the pool in the center, which is kept at a fixed depth to retard freezing.

The Mixing Basin

The water from the aerator enters the mixing basin, which is in and practically on a level with the second floor of the head house. It was placed there for two reasons in particular, first for purpose of observation and second, to reduce the length of chemical pipe lines.

The mixing basin is approximately 33 ft. by 12 ft., with an average depth of 5 ft. It has 4-in. brick baffle walls of around-the-end type spaced on about 2-ft. centers. The outlet from the mixing basin leads directly into a mixed water conduit which passes through the head house wall into the coagulating basins.

Coagulating Basins.

There are two coagulating basins, separated by a dividing wall, each 40 ft. by 81 ft., with an average depth of 16 ft. The capacity of the two basins is about 700,000 gals., providing a sedimentation period of 4.2 hours on a 4,000,000 gal. rate or 3 hours on a 6,000,000 gal. rate. The basins are covered with a concrete roof of the beam and slab type of construction. The roof is supported by 14-in. square columns spaced 10 ft. 4 in. both ways. Drainage of the basins is obtained by a 1 ft. slope in the floor with four 10-in. sluice gate outlets in sumps located at the low points. The inlet to each basin from the mixed water conduit is a 20-in. circular sluice gate, and two 30x36-in. sluice gates in the dividing wall provide a cross connection for operating the basins in series. An 8-in. brick baffle wall extends from one end down the center of each basin to within 10 ft. of the opposite end. The outlets to both basins are similar and consist of an overflow or skimming weir discharging through two 16-in. circular sluice gates to a settled water conduit lying directly over the influent or mixed water conduit. Both of these conduits are 24x28 in. in section and are supported along one wall of the basin. The settled water conduit re-enters the head house, passes through it to a right angle turn and down the center line of the filter pipe gallery.

The Filters

Six filters, 12 ft. by 19 ft. 6 in. each, have a filtering area of 234 sq. ft., and a rated capacity of 666,000 gal. or a total of 4,000,000 gals. per day. Each filter has three concrete wash water gutters which run across the width of the filter and discharge into an 18-in. main gutter which runs lengthwise. A 12-in. connection leads to the main drain in the pipe gallery. The influent to each filter is a 10-in. pipe.

The filtering medium consists of 30 ins. of sand 15 ins. of gravel, with underdrains of the Harrisburg type. The effluent passes out through an 8-in. rate controller and returns to the auxiliary filtered water storage basin underneath. The 12-in. wash water supply line is suspended directly beneath the concrete influent conduit in the pipe gallery with 12-in. laterals to each filter. The rate of wash is estimated at 15 gals. per sq. ft. per minute. A 4-in. connection for filtered water to waste is also provided. All of the valves are hydraulically operated from an operating table with the exception of the 4-in. waste valve, which has an extension stem leading to a nut in the operating floor above.

The pipe gallery is 11 ft. 6 ins. wide and the arrangement of the pipes is such that a clear space about 5 ft. wide and 7 ft. high down the center is provided. The main drain is of concrete and runs directly beneath the pipe gallery floor. The filters are divided in two sets, three on each side of the pipe gallery. Each set is supported upon an auxiliary filtered water basin 45x18 ft. by 11 ft. The outlet to both of these basins is into the filtered water storage basin.

Filtered Water Storage Basin

The filtered water storage basin is approximately 94x91 ft., and 14 ft. deep. With the two auxiliary basins beneath the filters, a total storage of approximately 890,000 gals. is provided. This is equivalent to 5.3 hours' storage at a 4,000,000 gal. rate. The floor of this basin is below ground water level and provision for uplift was necessary. The design adopted is an inverted flat slab with panels 10 ft. 8 ins. by 11 ft. 6 ins. The supports are 14-in. columns, which in turn support the roof. The roof is a beam and slab type with the slab support on four sides. A 2 ft. earth covering has been provided. The basin is baffled with 8-in. walls to prevent dead water areas. The outlet to this basin is into a conduit, low enough to drain the basin, which leads into the basement of the head house. Into this conduit the high lift and wash water pump suctions are connected.

The head house is a 4-story structure, including the basement. The basement contains heating plant, coal storage, elevator machinery, but principally the pipe connections to the pumps located on the first floor above.

Pumps

For high service duty two 3,000,000-gal. and two 5,000,000-gal. pumps are provided, so connected that each set may pump separately or in combination forming a two-stage pump. The wash water pump is a 5,000,000-gal. pump, designed for direct washing of the filter.

The second floor contains the offices, laboratory, chlorine room, shower bath and locker room on one side of a passageway and on the opposite side, the mixing basin and the lower portion of the chemical solution tanks with the orifice boxes. Two dry feed chemical machines are provided.

Alum will be stored on the third or top floor.

The second floor passage-way opens directly onto the operating floor of the filters, and the first or pump room floor connects down a few steps into the pipe gallery. A doorway at the opposite end of the pipe gallery is provided.

Architectural Features

The plant is located along the main line of the Pensylvania railroad, and on one of the principal thoroughfares of Whiting. It was decided, therefore, to make the plant artistic from an architectural standpoint as well as serviceable for operation.

The superstructure is of brick with a concrete shell. Stone window sills and copings, and a stone entranceway add to the attractiveness. The roof is flat with pyrobar roofing supported on concrete beams. The exterior walls of the basins are exposed on practically all sides and to relieve the monotony they are paneled and surmounted with a coping.

The filter sand has an effective size of not less than 0.35 nor more than 0.44 millimeters and a uniformity coefficient of not more than 1.65.

Costs

Some data showing the cost of the Whiting filter plant as compared with costs elsewhere are shown in Table I. The total cost including all items such as land, engineering and extras for both filter plant and high lift pumps was approximately $200,000. The work was carried out during the period of peak material prices and while labor was still scarce, most of heavy work being completed prior to August, 1920.

Operation

The plant was put into operation during November, 1920, and is now in charge of A. C. Bromschwig, formerly of the St. Louis filter plant. He has under him for the operation of the filter plant and high lift pumping station 6 men—two for each 8-hour shift.

It can not be said, of course, that the plant has yet reached its best operating routine, as this will require experience

TABLE I—SOME COMPARATIVE UNIT BIDS ON WATER FILTER PLANTS

		Earth Excavation Per Cu. Yd.		Reinforcing Steel Per Pound		Concrete Per Cu. Yd.	
	Year	Low Bid	Average 3 Lowest	Low Bid	Average 3 Lowest	Low Bid	Average 3 Lowest
Evanston, Ill.	1913	$0.90		$1.79		$13.90	
East Chicago, Ind.	1918	1.00	$1.30	10.00	$10.00	13.38	$17.65
Whiting, Ind.	1918	.77	1.18	5.50	4.87	17.50	(1)

(1) Estimated from lump sum bid.

with a variety of seasonal conditions. Some operating data may be of interest, however. During January filter runs averaged 8 hours and have now been extended to about 12 hours. With the relatively clear raw water, it has been found helpful to add lime at the rate of 0.7 grains per gal. in addition to alum at the rate of 1.5 grains per gal. The best combination of chemicals and points of application is, however, still to be worked out. Considerable floc appears necessary to clear or scrub the water of the petroleum taste.

The record shows three observations of oily flavor out of 48 taste tests. All three occurred on days following several days of southerly wind movement. This is, of course, not conclusive, but there is evidence of an increasing improvement in the quality of the filtered water at Whiting.

No trouble with algae has been reported.

General Considerations

In the opinion of the writer, the water supplies of this district should be studied broadly as influenced by industrial sewages. Four factors stand out: (a) The location of sewer outlets; (b) the location of water intakes; (c) the treatment of the sewage, and (d) the treatment of the water.

The problem will eventually be solved by the economical adjustment of these factors. It appears clear at the start that the treatment of the industrial sewages of large volume is likely to be the most costly. The construction of water purification plants (because the water supplies are very small in volume as compared with the sewages) is considerably less costly and is called for in any event as the first line of defense against bacterial pollution, material turbidity and other objectional qualities of the raw water. The effect of the industrial sewage on the fishing industry of the Illinois River will also need consideration. Well organized seasonal study of the factors involved is the first step.

This paper, by Mr. Greeley, was presented at the recent joint meeting of the Iowa and Illinois sections of the American Water Works Association.

PERSONAL ITEMS

George B. Gascoigne, Consulting Sanitary Engineer, Cleveland, Ohio, has been retained to report and prepare preliminary drawings upon sewerage and sewage disposal improvements for Springfield, O. Estimated cost, $1,000,000. Mr. E. E. Parsons, is City Manager of Springfield.

Alexander Murdoch recently became City Engineer of Chicago after passing a competitive examination conducted by the Civil Service Commission in which he had a rating of 92.7. Five engineers took the examination; only one other passed and he with a rating of 20 points lower than Mr. Murdoch. A native of Baltimore, Mr. Murdoch lived in Philadelphia for many years. Before coming to Chicago he was chairman of the Claims Board of the Emergency Fleet Corporation in charge of adjusting uncompleted war-time contracts. Formerly, he was Vice President and Chief Engineer of the Fidelity and Deposit Co. of Maryland, where he had charge of completing construction work taken over by his company as bondsmen after contractors had abandoned the work. He was for some time in the service of the city of Reading, Pa., serving first as assistant city engineer and later as city engineer. He is a graduate of the University of Pennsylvania.

Mr. F. Carl Martini, for 9 years assistant engineer in the Water Works Construction Bureau of the city of Chicago was recently promoted to the position of Engineer of Contracts in the city service.

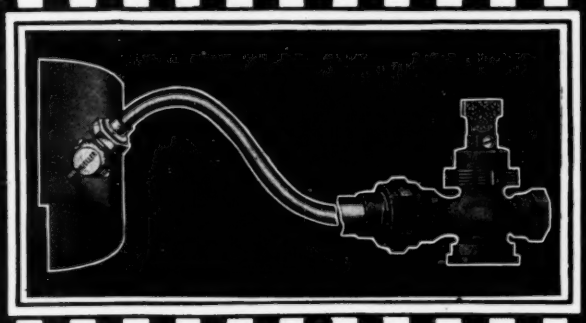
OPERATING A WATER WORKS PLANT UNDER STATE SUPERVISION

By C. M. Roos, Secretary, Cairo Water Co., Cairo, Ill.

After eight years of state regulation of public utilities in Illinois we are hearing much discussion of the questions of whether or not the law providing for such regulation should remain as it is, or be repealed entirely and go back to so-called "home rule," or be revised in some manner to correct certain alleged faults. Discussion of this utility regulation question by those who advocate "home rule," has brought forth expressions from various interests and classes throughout the entire state, which appear to be largely in the majority, favoring a continuation of state regulation as opposed to home rule.

Home Rule vs. State Regulation

Few questions in Illinois at present are attracting as much attention from commercial organizations, business men, bankers, professional men, municipal authorities and labor organizations as this one of regulation of public utilities. In all of the discussion little has been said



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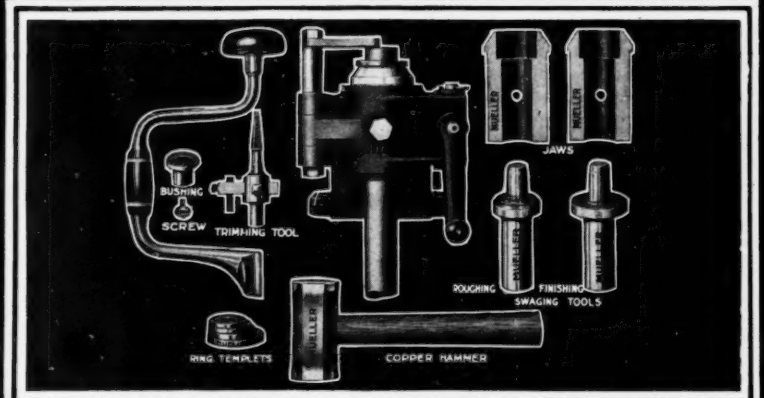

publically by the utilities themselves. It is obvious why there should be hesitancy on the part of the utilities in going on record in a discussion of this character, because past history proves that there is a tendency on the part of the public to look upon statements by public utilities with a certain suspicion, and not to accept them in the good faith which should exist if co-operation and best results for all interests concerned are to be obtained.

But have we not reached the time when common sense, good business for all concerned, and the best interests of the general public demand that the experience, opinions and advice of public utilities be heard in the discussion of this and other similar utility questions which vitally affect the public? Certainly no other interests are better qualified to participate in the discussion of public utility problems than the public utilities themselves. The woeful lack of intelligent understanding on the part of the general public of some of the vexing utility problems of today is largely because the utilities have hesitated frankly and openly to discuss these problems and to take the people into their confidence.

People Do Not Understand Utilities' Predicament

This entire situation is largely due to the attitude which the utilities have taken toward the general public. Utilities have not talked to the people as freely as they should. The utility business is the most vital business in any community, having a more direct bearing on the community welfare, progress and convenience than any other class of industry. There are few classes of business more dignified and contributing more to the comforts and welfare of man and which are today operated in better faith than the public utilities. Utilities have much to talk to the people about, many interesting and vital things about the business to explain, and the sooner the general public knows the real facts about the utility business, coming frankly and in good faith from the utilities themselves, the easier will it be, wisely and successfully, to solve some of the problems with which we struggle today.

If the public really knew conditions as they exist today in the public utility business there would be little difficulty in solving our utility problems, the utilities would be in a position to do financing to better advantage, confidence in utility securities would not be shaken and utilities would be in a position to make needed improvements and extensions, all of which would be directly to the advantage and interest of the consumers and would contribute directly to community development and the re-establishment of general business confidence.

Public utility educational campaigns are needed and the burden of conducting them rests upon the shoulders of the utilities. Is it not true in practically every community that the public criticises and openly attacks its public utilities more freely than any other class of industry within the community, and yet only a very small percentage of the citizens of a city will ever take the time and enough direct interest in their utilities even to visit the plants, see how the work is done or talk with the managers and learn first hand some of the things they should know about this most vital part of their community life and existence?

Utilities Had No War Time Profits

A recent personal experience in talking with a prominent business man who has the direct management of a large industry, illustrates how grossly misunderstood is the position in which the utilities have been thrust during recent years by men whose intelligence would not permit such an attitude if they knew the inside of the utility business. In commenting on a recent increase in rates for water after hearing the explanation that the last year's business resulted in an operating loss of about $12,000, the business man said: "Your company's investment in this city represents approximately $500,000, and my judgment is that it could not be duplicated for anything like such an amount. You show an operating loss of $12,000 for one year on a half million dollar investment. I know of a business in this city with an investment of $100,000, which showed an operating loss last year of more than $12,000. Why should you find fault with such a small loss with such a large investment as you have, as you should be better able to stand it than the $100,000 business?" Such comment to the utility man is really amusing, but it must be regarded seriously, as the man who said it was serious about it, and he represents an intelligent class in the community. This man does not stop to think that the $100,000 business to which he referred earned profits of several times its capitalization during the fat years of and following the war, and now has a reserve in actual cash sufficient to withstand the strain of many years of loss at the rate of $12,000 per year. In contrast with this condition the

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Valuation of Public Utilities for Rate Making and Purchase.

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utility business with five times the investment not only failed to show a return on the basis of its large investment, but in most cities showed a loss during most of the period of high commodity prices, and now is not only without a cash reserve, but has its credit impaired and an extremely low market for its securities.

What the Educational Program Should Include

The public utility educational program should include:

1. Interesting members of commercial organizations, city councils, women's clubs and civic and labor organizations in making careful inspections of the utility plants. These visits should be made in groups and instructors at the plants should explain details of operation, maintenance, expenses, etc.

2. When at all practical local citizens should invest financially in their local utilities. The people themselves can do much to make their utility investments the safest and most desirable to be found, and as a result they will not only profit financially directly from their investment, but indirectly in service rendered by the utilities and in the ability of the utilities to keep pace or set the pace for community development and expansion.

3. Local boards of education should be led to see the importance and necessity of having pupils of all grades in the public schools study their local utilities. In most cities the utilities could provide lectures periodically to the school children, and also to the school instructors who, in turn, could teach the subject in connection with their regular class studies.

4. Newspaper advertising in the form of heart-to-heart talks with the people. Enclosure slips in local mail telling the consumers about their utilities.

5. It should be known in the community that questions and complaints or criticism about service, etc., are solicited by the utilities instead of discouraged, so that consumers will not hesitate to go direct to the utilities about any matter in connection with their business in the community.

Education Along Three Lines

Education of the public should be along three distinct lines, viz.:

1. The people should take a real and direct interest (financial if possible) in local utilities, familiarizing themselves with the business to the extent possible.

2. To select capable well qualified men to represent them in their government, local and otherwise, regardless of political affiliation and to trust to the judgment of experts in deciding questions of a technical or professional character.

3. To be less hasty in openly criticising constituted authority unless or until the basis for criticism is well and intelligently established. Unless the attitude of our American people toward constituted authority changes it will soon be difficult to persuade highly qualified men to serve in public office. Lack of confidence in constituted authority destroys the very basis of sound government and the results are evident on every hand.

We are living in an age when the people demand control and rule as never before. The rights of the people must be defended and preserved, as this is a country of and for the people, and no one has any authority whatever, civil or otherwise, to deprive any citizen, who respects the laws established by the majority, of his rights as a citizen. But rule or control or regulation by the people does not mean that safety, economy and efficiency in all channels of civic and industrial activities can be secured by direct supervision or regulation by the masses, who can not be expected to be qualified to pass wisely on all phases of community life and industry. Thus the judgment of a doctor of medicine would scarcely be good in deciding a technical question in connection with the regulation of a water works. The same can be said of many other classes of citizens without in any sense reflecting upon their intelligence.

Rule by the people in proper common sense form means that they select or provide those whose business it shall be, impartially, to represent the people in the various positions or offices, and who shall be considered as properly constituted authority in their respective positions. It is presupposed that such constituted authority shall either be well qualified to pass intelligently on the questions in their line, or who will proceed to qualify for the work by familiarizing themselves thoroughly with it.

Unique Aspects of the Water Works Business

The water works business is unique in many respects as compared with private industries. It is by nature a monopoly in its community which it serves. It is to the interest of both the consumer and the operator that it be a monopoly. Duplication of investments in public water supplies in any city invariably results in the necessity of finally consolidating the systems, thus throwing upon the consumers

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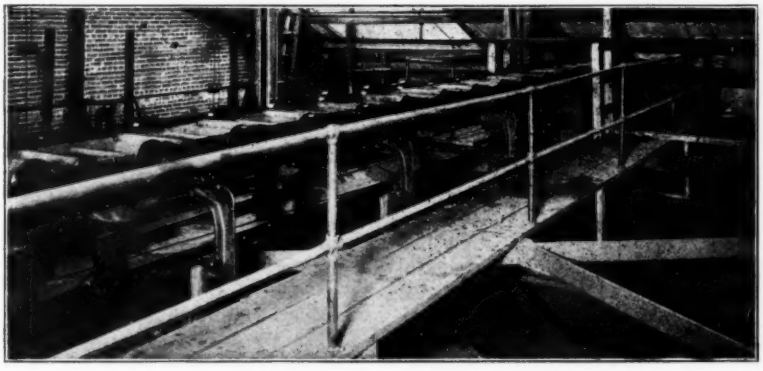

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the burden of supporting a larger investment than would otherwise be necessary.

A water works is unique in that the investment in it is or should always be of a permanent character. The very nature of the business requires this. Our limited franchises (a relic of Illinois home rule) prevent economical financing of permanent investments in water works and also prevent private utility corporations from installing in communities as high type equipment as otherwise could be provided. Attempts by local communities to fasten upon water works utilities iron clad contracts in the form of franchises, and at the same time demand immense investments in equipment, the protection of which depends directly upon the bargaining again at the expiration of the franchise with local authorities who though otherwise intelligent men have no technical knowledge of water works and cannot be expected to have, cannot but result in working havoc at no distant date. The truth of this will certainly soon dawn upon many cities much to their sorrow.

A water works plant is unique in that it is expected to operate continuously whether costs of supplies are high or low, regardless of labor troubles or transportation difficulties, whether the business is profitable or not, whether the company's credit is good or bad, and when repairs are difficult and expensive to make on account of inability to cease operations for a period. In addition to all of this the plant is supposed to be operated on the basis of a bare legal interest rate of return on its investment as its maximum return, with no guarantee against losses. No profit is supposed to be figured in water work business. An interest rate of return on an investment in an industry cannot be considered as profit. To insure holding the return to utilities at the rock bottom or below, the public stands by dictating the rates to be charged for service.

Contracts With Private Industry

Now in contrast with a water works plant, note that a private industry has the sky as its limit for profit and when business is bad it closes its doors and lays off its employees, thus cutting down expenses. It ceases operations at will to make repairs at ease and economically. Its machinery and equipment usually operate only about 8 or 9 hours per day and 6 days per week, which gives the mechanical department ample opportunity to do emergency work to good advantage. It markets its securities to much better advantage than a water company possibly can. It has an unlimited field for development. Finally, it is its own boss in the sense that it has no public regulation of its rates or prices for its product.

These statements as to conditions under which a water works utility must operate as compared with a private industry is true in a sense whether it is under state regulation or home rule. In both cases it is public regulation by the people. The question under discussion by so many in our state is which method of regulation is to the best interests of all concerned.

Public Utilities Must be Regulated

The public utility business by nature should be and must expect to be subject to public regulation. The only real fault or complaint along this line which utilities should file is that it is discriminatory and grossly unjust that the public should "regulate" utilities, which mean keeping profits down to rock bottom and far below in many instances and at the same time not "regulate" the control of the state's natural resources and necessary commodities upon which utilities must depend to operate their plants.

Public control of utilities and failure to control the business which furnishes utilities with necessary operating supplies has resulted during the last few years in the utilities' already deflated purse becoming leaner and leaner, with the contents of same filling the purse of private industry in enormous profits. The State Public Utilities Commission is not at fault in this. The fault lies in the provision by our government for regulation of one class of business while another class is earning large profits from money from the first class, all unmolested, because no authority has been provided to regulate certain private industries.

This discussion is not presented for the purpose of registering an objection on the part of a public utility against public control of its business. Its object in part is to state that both home rule and state regulation of utilities are controlled by the people, of which control so many are jealous. Its object further is to call attention to the fact that the general public does not realize that the public utilities have suffered enormously in depleted earnings and heavy losses during the last few years, when other industries were growing fat, and that the small increases in rates authorized from time to time recently by the State Public Utilities Commission were absolutely necessary in practically every case to barely keep the utilities alive.

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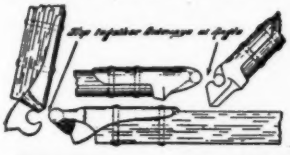

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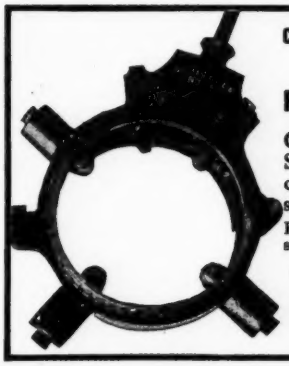

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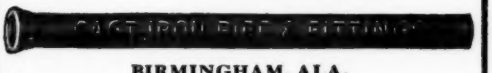

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What the People Have Forgotten

The people of our state do not appear to remember that from January 1, 1913, to January 1, 1917, the State Public Utilities Commission lowered rates for utility service throughout the state to the extent that over $5,000,000 was saved to the consumers during that period.

The general public apparently does not realize the tremendous significance of the fact that during the last few years the increase in the cost of money to the public utilities has been three times that to manufacturing industries, and that the only way capital can be secured for our utilities is in the open market in competition with these other more attractive securities.

Our people fail to realize the significance of the fact that in the United States today the investment in public utilities, exclusive of railroads, amounts to approximately $15,000,000,000, of which about $1,250,000,000 is in Illinois, and that this immense investment has not been made by a favored few, but by the people themselves who hold utility securities. In Chicago alone $565,000,000 is invested in utility companies, being more than twice as large as Chicago's investment in its own utilities. These figures represent book value. Reproduction of our utilities as of today would show a much larger investment than is indicated by these figures here submitted.

Capital Invested in Utilities Not Appreciated

The general public does not realize that it is benefited directly and otherwise more by the capital invested in its public utilities than in any other enterprise within its borders, yet the tendency on the part of the public generally is to abuse or fail to appreciate capital invested in its utilities more than in any other industry.

Those who are opposing state regulation do not know the great value and importance of having uniform systems of accounting, well-established standards for service, equipment, etc., for all the utilities in force throughout the state, all of which have been brought about by state regulation and which cannot be provided or maintained otherwise.

The general public is woefully ignorant, indifferent or forgetful of all of this, largely because the utilities have failed to talk frankly to the people as they should.

While the public utilities as a class have hesitated to go on record in expressing an opinion about state regulation, yet it is a fact that many utilities have chafed under the apparent delays in securing absolutely necessary relief through the State Utilities Commission, and when relief would finally come it would often be inadequate to provide for increases in operating costs subsequent to the time when applications for increased rates were filed.

Composing Conflicting Interests

We as utilities must realize the fact that the State Commission has been dealing with a public sentiment invariably strongly prejudiced against public utilities, which made it difficult for the people to understand the absolute necessity and justice of increased rates for service. The Commission, a representative of the people, has the people to consider as well as the utilities. Few of our communities realize as we utilities do that they owe the State Public Utilities Commission a real debt of gratitude for having tided the utility business of the state over the most dangerous and difficult period in history, when commodity prices soared from 100 to 300 per cent. above normal, and at the same time holding rates for utility service down to a very small fraction of this increase in general commodity costs.

Though the utilities have suffered greatly during this difficult period, it is a remarkable fact that our state regulatory body has handled the situation without a single case of a utility ceasing to function.

Rates for service seems to be the point around which practically all criticism of state regulation on the part of the general public centers. Illinois has no reason to complain about its utility rates for service, particularly about water rates. The average highest rate for water in Illinois is .304 cts., and the average best commercial rate is .13 cts. per thousand gallons, as of Jan. 1, 1921, which is considerably lower than the average rates in other states.

Confidence in utility investments must be restored. The interests of the public will best be served by having it so, regardless of the direct effect it may have on the utilities themselves.

Regardless of the attitude of the public utilities toward state regulation, anything less than state regulation of our utilities will mark the complete collapse of the market for utilities securities and thus destroy the very foundation and framework of our entire economic structure.

This paper by Mr. Roos was read before the recent joint meeting of the Illinois and Iowa Sections of the American Water Works Association.

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Construction News and Equipment

EQUIPMENT EMPLOYED ON ROAD CONSTRUCTION IN MINNESOTA IN 1920

By O. L. Kipp, Construction Engineer, Minnesota Highway Department, 920 Guardian Life Bldg., St. Paul, Minn.

Plans were prepared sufficiently in advance during the early part of 1920 so that a large amount of work was placed under contract during the early part of the season. In fact, by the first of June it became apparent that it would not be possible to place under contract all of the work which had been contemplated by the counties, and for which plans were being rapidly completed. A questionnaire was therefore sent to all the highway engineers in the state, requesting information as to the status of the uncompleted contracts in each county and the amount of the various types of road building equipment actually in service, and the date on which any of it would be released for additional work. The information secured by this questionnaire confirmed the opinion of the department that the amount of work already placed under contract was more than sufficient to keep all of the available equipment busy for the remainder of the season, and it was therefore determined to issue an order to abandon further lettings of road work, except where it could be shown that equipment was available for the construction of the project or where the work was of an unusually urgent nature.

A tabulation of the data received on this questionnaire revealed the fact that the number of men and the quantity of equipment and stock actually engaged in highway construction in the state comprised the following totals:

6,092 men employed, 36 steam shovels, 26 locomotives, 281 dump cars, 98,523 lin. ft. of track, 145 elevating graders, 363 blade graders, 1,168 wheel scrapers, 1,011 slip scrapers, 526 fresnos, 1,460 dump wagons, 69 mixers, 30 finishing machines, 466 motor trucks, 91 trailer wagons, 156 tractors, 57 loading bins, 31 belt loaders, 14 derricks, 23 drag lines, 26 screens, 6,212 horses and mules, 18 pile drivers, 44 pumps 13,000 lin. ft. pipe, 2 asphaltic heating plants, and 2 steam rollers.

The total volume of work which the foregoing equipment were able to complete during the season of 1920, was as follows:

Grading—1,120.9 miles, comprising 9,409,849 cu. yds. of excavation, costing $5,737,016.36, the average cost per cu. yd. for the grading being 61 cents, which includes the cost of overhaul, loose and solid rock excavation.

Gravelling—831.69 miles, comprising 1,023,992 cu. yds. of gravelling costing $2,481,700.82. This is an average of 1,230 cu. yds. of gravel per mile, costing $2.42 per cu. yd.

Paving—12.39 miles of Asphaltic Concrete, comprising 107,546 sq. yds. of paving costing $325,699.08. Also 66.98 miles of Portland Cement Concrete, comprising 714,361 sq. yds. of paving costing $2,228,616.69.

Clearing and Grubbing—3,275.18 acres, costing $240,540.89.

Guard Rail—205,555 lin. ft. or 39.0 miles, costing $134,529.33, which is an average cost of $3,449.48 per mile.

Tile Drain—613,341 lin. ft., or 116 miles, costing $166,915.42, which is an average cost of $1,611.34 per mile.

Portable Culverts—153,923 lin. ft., costing $332,102.87.

Monolithic Culverts—335, containing 7,054.81 cu. yds. of concrete, costing $325,112.98.

Bridges—198, costing $1,716,797.91.

Total Cost of Construction—Completed on state roads in the year 1920, including miscellaneous items not enumerated above $14,405,091.06.

State Aid—$1,250,202.20 paid on 1920 construction.

Federal Aid—$2,711,620.00 paid on 1920 construction.

During the season of 1920 17 paving contracts were under construction, in which various methods and types of equipment were used. The high records for progress were made on three projects, namely: Project No. 114, Sherburne County. Project No. 107, Watouwan County, and Project No. 64, Rice County.

On the first of these projects a central mixing plant was used, which was equipped with a 6-bag mixer. The average pavement laid on this contract was

870 sq. yds. per day, with a maximum of 2,196 sq. yds. laid in an actual running time of slightly less than 10 hours. The plant was so equipped that the mixer discharged in 8 seconds, and the time for charging the mixer was not over 5 seconds. It is, therefore, apparent that this equipment was capable under perfect conditions of delivering an even greater yardage during a 10-hour day.

On the second of these a central proportioning plant was used, the material being hauled from this plant with 2 and 2½ ton trucks, equipped with pneumatic tires, and an ordinary dump body divided into two compartments. A 4-bag paving mixer was used on this work, and the average output per day was 681 sq. yds. The maximum output was 1658 sq. yds. The subgrade on this project was in a very satisfactory condition during the time of operation, except for a period of a week or ten days when frequent rains seriously affected the progress of the work and the general subgrade conditions.

On the third of these paving jobs a central proportioning plant was used with industrial haul from the plant to the mixer. Both steam and gasoline engines were used, but it is believed that the gasoline engines proved more satisfactory on account of their light weight and low center of gravity. The mixing equipment consisted of a mixer mounted on a steam shovel base, and a tower of structural steel built over it for hoisting the batch boxes. The base also carries the hoisting engine used for this purpose. The whole is pulled by a 35-horsepower steam tractor, which supplies steam to both the hoist engines and the upright engine, which turns the mixer. The average output of this plant was 736 sq. yds. per day, while the maximum output was 2,145 sq. yds., which were laid in 10 hours and 21 minutes mixing running time.

The specifications on all of this work required a 1-2-4 mix, and the average thickness was a 7 1-5 ins., the pavement being 6½ ins. at the side and 7½ ins. at the center, with a curved crown and flat base.

The engineering and supervision of the 1920 construction was under the immediate supervision of the highway engineers of the counties in which the work was situated. The method of handling the work varied, according to the requirements of the various projects. The number of engineers employed in supervising this work is estimated at 275 engineers and instrument men, besides rodmen, chainmen, and miscellaneous assistants. This estimate does not include the force employed by the central office of the highway department.

HOUSTON CONSTRUCTION CO. PAVES 109 FT. PER HOUR

Winter weather has no effect on road building programs in Texas. Early in January the Houston Construction Co., Houston, Texas, started work on a 15½ mile contract on State Highway No. 3, Orange and Beaumont Road.

Remarkable results are being attained on this work. When W. S. Warfield, Vice President and General Manager of the Company, bought his 21-E Smith Paver last Fall, he looked over the work done by Alan Jay Parrish, who established a 1920 record of 779 ft. in 10 hours, with an average of 450 ft. per day for the whole season. Mr. Warfield claimed at that time that he would break this record. And it looks as though he would —in fact, he has already laid almost as much in a seven hour day as Mr. Parrish did in ten hours.

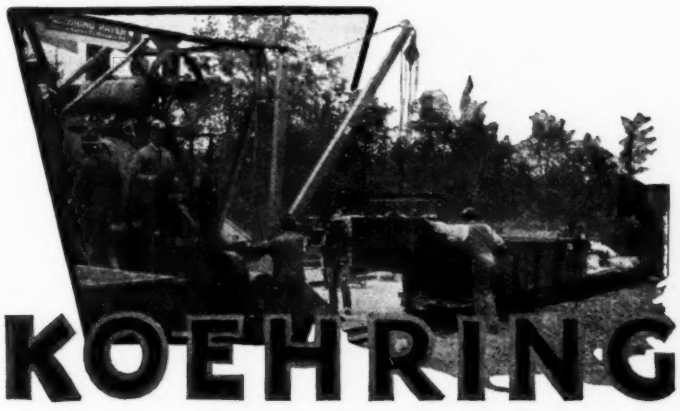
The Texas job is utilizing Lee Body trucks instead of the industrial railway system for transporting the aggregates to the paving mixer. The material yards are located at Orange, Tex. right along the road that is being built. A Byers crane connected to a stiff leg derrick, with a clam shell bucket, handles all the materials, loading them into material bins direct from the cars on the railway sidings.

Fifteen trucks are used to keep the paving mixer supplied with the aggregates. The trucks are loaded from material bins which measure the correct quantities of sand, stone and cement automatically. A four bag batch, 1-2-3½ proportioned full minute mix is required by the state.

The trucks are run onto a turn-table just ahead of the paver, where they are turned and then backed up to the paver skip. They then dump their loads directly into the closed end skip.

The working schedule has all been well arranged so that there are only 43 men on the entire job, including those at the material yards, on the trucks and at the paving mixer and finishing machine.

It is a 16 ft. road, average thickness 6¼-in. On the first five days, 3,600 lin. ft. were laid, an average of 720 ft. per day. The biggest single day's run was 762 ft. in seven hours. Mr. Warfield ex-



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The Paver of Low Mixing Cost

EVERY second of time saving means money saving—profit making on a paving job. The paver that is lowest in cubic yard mixing cost is the cheapest mixer. Any other is costly.

Extra Yardage Built in

Koehring mixers *are designed* to give the lowest mixing cost. Centralized control—the many automatic actions found only on Koehrings enable the operator to maintain that day after day speed of operation which means a big season's extra yardage.

Heavy Duty Construction

Heavy duty construction is but another term for dependability—and dependability pays a big extra profit in trouble-free continuous operation—which means lowest mixing cost.

Koehring mixed concrete is dominant strength concrete.

Write for Koehring Paver Details

Koehring low mix cost—dependability—can't be wished into a mixer. It must be built in. It is built into Koehrings. Investigate. Write for details of Koehring pavers.

Koehring Machine Co.
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KOEHRING SIZES
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Pavers: 10, 14, 21 and 28 cubic feet mixed concrete. Standard wet batch rating. Boom and bucket and spout distribution, steam and gasoline. Loading derrick, multiplane traction.

Construction Mixers. Sizes: 4, 7, 10, 14, 21, 28 cubic feet mixed concrete.

pects to put down at least 1,000 ft. in nine hours after the job gets going "full blast." He claims the mixer will handle it easily if the materials can be brought up fast enough.

Blaw-Knox road forms are being used and a Lakewood tamping and finishing machine. The paver is gasoline equipped. A swivel spout is used instead of boom and bucket for delivery of concrete to the road.

THE USE OF TRACTORS ON ROAD CONSTRUCTION AND MAINTENANCE WORK

By Louis A. Wilson, Highway Engineer, The Holt Mfg. Co., Peoria, Ill.

To handle every phase of road building, the tractor must be able to do all or more than men and teams could do; the tractor must do this work as efficiently and in a workmanlike manner at a lower cost. The ability of the "caterpillar" tractor, for example, to handle this work successfully can better be appreciated by this detailed account of performance records gathered from many operations over the entire United States.

Stump Pulling

Clearing the right-of-way is quite often the first step necessary before the grading operations can begin. In the past, stumps have been removed largely by the use of dynamite. The power and flexibility of the tractor has provided a new, and in many cases a more economical, method for removing these stumps.

FIG. 1. TEN-TON "CATERPILLAR" PULLING OUT A 24-IN. STUMP.

Mr. Guy L. Shaw has used the 5-ton "caterpillar" during the past two years, and in stump pulling has established an average daily record of 200 stumps or trees. This operation was in the Illinois river bottom lands, completely covered by willow trees from 6 to 18 ins. in diameter. Figuring all the charges that entered into his daily operating costs, the price per stump or tree removed was approximately 15c.

The "American Highway Engineering Hand Book," by Arthur H. Blanchard, page 421, under the subheading of "Pulling Stumps," states the following: "The Holt 'caterpillar,' 60-h.p. (10-ton) will remove sound stumps up to 18 or 20 ins., and the 'caterpillar' feature gives it a very decided advantage in getting over uneven or swampy ground. * * * It has been known to pull 100 stumps per hour for 7½ hours, and on a speed test has also averaged 450 stumps per day. * * *"

It is well to remember in this connection that pulling stumps by this method eliminates the hazard contingent with the use of dynamite and nitroglycerine caps. The tractor requires but two or three men, one to drive the tractor and one or two men to make hitches on the stumps. It not only pulls the stumps out, but with the same power it drags them to the pile where they are burned, thus reducing the labor necessary in clearing up the land after the stumps have been blasted out, and pieces strewn all over the ground.

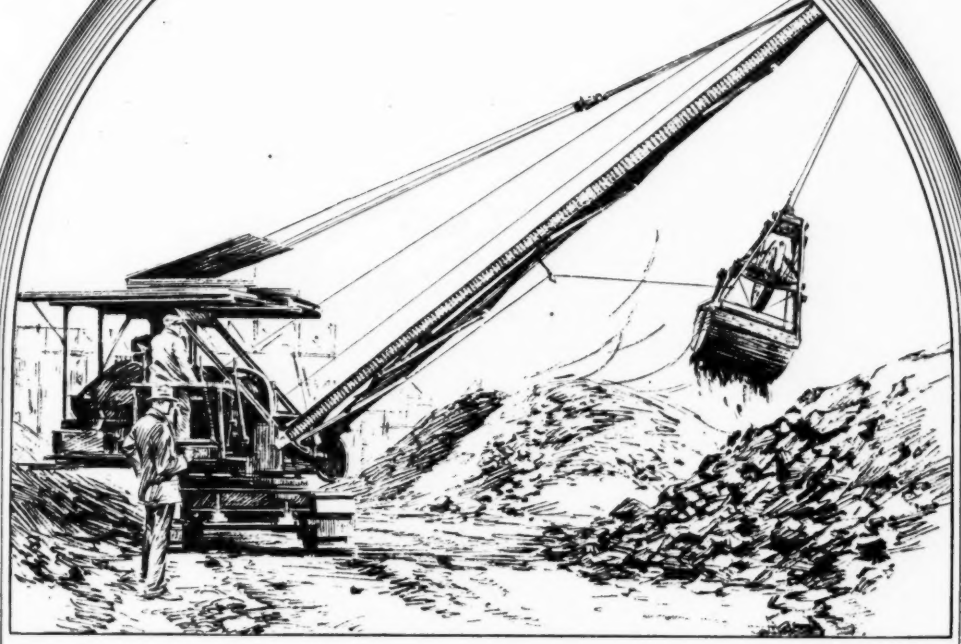
Tractors and Wheel Scrapers

After the roadway has been cleared of trees and stumps, various methods of grading may then progress. Many road builders prefer wheeler outfits. The tractor with a train of wheelers gives a new method of moving dirt. Both the 5 and 10-ton "caterpillar" are used with wheel scrapers.

The Maney wheelers, made by the Baker Manufacturing Company, Springfield, Ill., have a train hitch which permits the use of six or eight Maney wheelers behind a 10-ton "caterpillar." Two men operate the outfit, one man to drive the tractor and one man to load and dump the train of six wheelers. This work is being handled by Mr. A. G. Millard, contractor, Okmulgee, Okla. He moves dirt from 300 to 1,300 ft. During the past season 300 cu. yds. of dirt was the smallest amount moved in any one day. Daily yardage runs from 300 up to 600.

To obtain such daily performance records requires power, traction and the ability of the tractor to handle the train of scrapers in narrow quarters, over fresh fills, and all other conditions of rough going which present themselves in the ordinary routine of building a road. The "caterpillar," with six Maney wheelers, can be turned in a space not to exceed 22 ft. This application of the tractor represents power, speed, increased daily

P&H



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Equipped with a clam shell bucket the P & H Excavator-Crane grabs its loads, whisks it through the air, drops it and is back for another bite. Coal, ashes, gravel, sand, earth, are thus handled.

With a magnet and one man to operate, a P & H can load, unload or move pig iron, scrap, building steel.

Exchange a digging bucket for a magnet, and the same man can excavate a cellar or a ditch, level a hill or road; and with a back-filling bucket fill up the ditch again.

With other attachments to the hook, pile driving can be done; beams or structural pieces for bridges or buildings can be set. For speed and ease of handling most anything, a P & H is adapted. There are so many uses for it that it pays dividends at all times.

New Bulletin 5X has many photographic illustrations of applications. A copy is yours for the asking.

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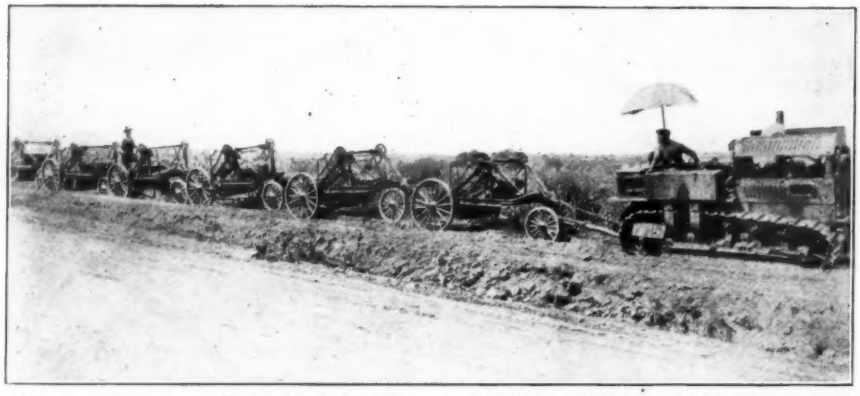


FIG. 2. THE A. G. WILLARD OUTFIT, A 10-TON "CATERPILLAR" WITH SIX "MANEY" WHEELERS MOVING 300 TO 500 CU. YDS. OF EARTH PER DAY.

yardage, and reduces the cost per cubic yard.

In the mountainous part of Kentucky, where road grading is quite often allotted to the steam shovel, two 5-ton "caterpillars," each with two "Maney" wheelers, are doing the work cheaper and faster than had heretofore been done by the steam shovel and a string of wagons. Mitchell, Townsend & Carter, Clay, Ky., with 4 "Maney" wheelers, 2 tractors and only 6 men, move an average of 550 cu. yds. of dirt per day, a distance of approximately 500 ft. They cut down heavy grades and make deep fills with this outfit. Not being tied down by custom or habit, these contractors have found in the tractor power, economy and speed in moving dirt with wheel scrapers.

Tractors and Elevating Graders

In some parts of the country the elevating grader is the predominating method of moving dirt. Reports read by the Research Committee at the annual meeting of the Northwestern Association of General Contractors, Minneapolis, Minn., March 11 and 12, 1921, established the fact that "caterpillar" tractors increased the daily output of an elevating grader about 30 per cent. The report further indicated that the contractor operating a grader with teams will sooner or later be forced to get rid of the stock and use tractors. The cost of feeding and wintering stock is an economic waste. Ordinarily a 10-ton "caterpillar" will replace 12 to 16, and, many times, 18 head of horses or mules on an elevating grader. The tractor speeds up the work, increases the yardage per day, and reduces the daily costs.

Some contractors have gone even farther in motorizing their elevating grader outfit and use 5-ton "caterpillars" to pull the dump wagons. The 5-ton will take 2 or 3 ordinary dump wagons, or 1 or 2 3½-yd. dump wagons. In either case, the 5-ton will replace 2 or 3 drivers and 6 to 8 mules, and will move faster and more continuously and work harder and will rest less than stock could be expected to do.

Comparative figures on the costs of operating elevating graders with teams and

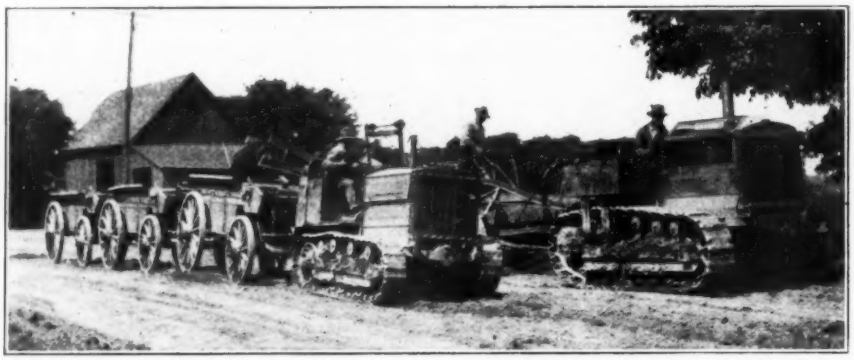


FIG. 3. A 10-TON "CATERPILLAR" ON AN ELEVATING GRADER WITH TWO 5-TONNERS HANDLING THREE DUMP WAGONS EACH.

Here Is a Road Maintainer Every City and Town Needs This Year

At last—a motor-driven, self-contained road maintainer that is low in first cost and in operating cost, yet high grade mechanically in every respect.

More and Better Work

Under average conditions, the Utilitor Road Maintainer will do more and better work than a three-horse outfit. One mile of almost impassable, rutted dirt road can be dragged into boulevard condition in six hours at a cost of $5.00.

Very Low Operating Expense

After a road has been put into good condition, it can be maintained for from one dollar to one dollar and a half per mile—depending upon the width of the road.

No More Poor Roads or Streets

There is no reason from this time on why any city, town or county should have poor roads or streets. Experience proves that it is not how BIG a drag is used, but how OFTEN a road is dragged—that counts.

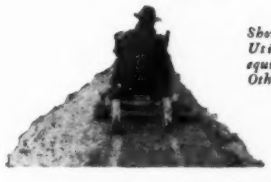
Investigate Its Many Advantages

This outfit is very simple. A sixteen-year-old boy can operate the machine and do a good job.

It can be turned in a ten-foot radius, making it possible to go over bad spots in the road many times without covering unnecessary ground.

Write for illustrated folder which shows photographic examples of work done by the Utilitor Road Maintainer. Please Address Sales Division R 12.

MIDWEST ENGINE COMPANY
INDIANAPOLIS, U. S. A.



Showing side and rear view of Utilitor Road Maintainer equipped with five-foot drag. Other sizes supplied on request

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When Material Runs to Depth Exceeding 15 Ft., or is Under Water, Engineers Advise Installation of a

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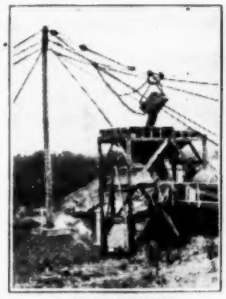
CONVEYING

They are suited to digging either loose or hard packed material, operate with equal efficiency whether gravel is in a dry pit or partly under water, and have no equal for taking gravel from the bottom of a stream or pond.

Evidence of how Sauerman cableways are contributing to the success of hundreds of commercial sand and gravel producers is published in Pamphlet No. 14, a copy of which will be sent on request. If your gravel deposit is shallow, or lies on a hillside, ask also for Pamphlet No. 12, describing Sauerman Power Drag Scrapers.



DUMPING

SAUERMAN BROS.
1142 Monadnock Bldg. CHICAGO

operating elevating graders with tractors show quite a variance in daily savings in favor of the "caterpillars." The saving effected by the use of tractors varies from $30 to $75 per day, depending upon the efficiency of the operation and the nature of the country in which the outfit is being worked.

Fig. 4 illustrates the outfit of W. C. Mullen, contractor, Vicksburg, Miss. On this work, a race track, Mr. Mullen established a record for moving dirt with elevating graders. The following data, covering this operation, will show in detail the various items entering into the cost on this work, the equipment used, and the high daily yardage maintained throughout the year as a result of the tractor's consistent performance:

Size of "caterpillar," 10-ton.
Western elevating grader.
Length of run, 500 ft.
Width of cut, 50 ft.
Number of dump wagons, 14.
Capacity of dump wagons, 1½ yds.
Time to load, 20 secs.
Time to change wagons, 15 secs.
Total yds. loaded per day, 1,200 to 1,500.
Distance of haul, average, 700 ft.
Length of work day, 10 hrs.
Average day's work, 1,350 yds.
Number of teams, 14.
Number of mules per team, 4.
Number of drivers, 14.
Number of wagons, 14.
Capacity of wagons, 1½ yds.
Time of load and change, 35 secs.
Total yds. loaded per day, 1,200-1,500.
Distance of haul, average, 700 ft.
Length of work day, 10 hrs.

Daily Operating Costs

Team and Wagon Costs:	
Team and wagon and harness investment—	
62 mules at $500 each	$31,000.00
14 wagons, 62 harness	5,750.00
Daily interest on investment at 8 per cent., 240 days	$12.25
Daily depreciation at 20 per cent., 240 days yr	30.62
Repairs	1.00
14 drivers' wages at $3	42.00
Feed for 62 mules at $456.25 per yr. each for each of 240 work days, each mule $1.90—62 head	117.80
Board of 14 drivers at $1	14.00
Cost for hauling 1,350 yds	$217.67
Machinery Costs:	
"Caterpillar" and elevating grader investment	$8,500.00
Interest on investment per day at 8 per cent., 240 days	$2.83
Depreciation, based on 20 per cent. and 240 days per year	7.08
Repairs	3.00
Operator's wages	8.00
39 gals. gasoline at 30c gal	11.70
¾ gal. motor oil at 50½c gal	.38
1/10 gal. trans. oil at 70c gal	.07
4 gals. track oil at 18c gal	.72
4 lbs. grease at 15c per lb	.60
Board of 2 men at $1	2.00
Helper's wages (grader man)	4.00
Cost of loading 1,350 yds	$40.38
Cost for loading	$40.38
Cost for hauling	217.67
	$258.05
Cost per yd. for loading	.0299c
Cost per yd. for hauling	.1612c
	.1911c

Sixty-two mules were figured through the foregoing, as that is the number Mr. Mullen keeps on hand to insure 52 head ready for work. He says the "caterpillar" does the work of 32 mules.

Such records as these are continually gathered by the research division of the Holt Manufacturing Company. The figures in these reports are taken from the contractors' records, and are approved by the contractor himself before they are released. In this way the company is in constant touch with the field conditions under which the tractors are operating and with the results being obtained by the user. Men handling this research division are engineers who are familiar with the practical application of tractors to elevating graders and other dirt-moving equipment.

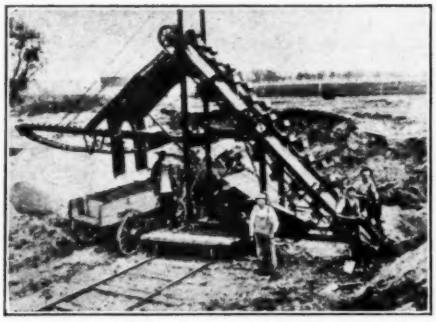
Tractors and Blade Graders

Probably the economy of using tractors for handling blade graders can best be appreciated by a condensed report from seven counties in Georgia. These counties have kept records for years, showing the costs of this work when handled by mules and the costs of similar work since they installed "caterpillar" tractors.

In the seven counties 11 "caterpillar" tractors did the same work in one year which formerly required 239 mules to do. The table and brief analysis of the seven Georgia counties here given show a condensed report of the economy and speed effected.

The Michigan Jr. Gravel Screener and Loader

Takes Gravel out of Pit or Pile, Screens out Sand and Stones and Loads the Gravel into Wagons or Trucks.



Calhoun County (Mich.) owns *four* machines, and contractors own *three* others, making *seven* in one county.

The Michigan Jr. holds the low record of cost of handling screeded gravel from pit to wagon or truck. This is the all-important consideration, Mr. Contractor. This saving is your profit.

Machine runs up and down side of pit or pile on a track and takes off slice of about ***four*** ft. each time. After going along track once, track is moved over and loader returned along side of pit or pile.

The Screener and loader is self-contained, furnishing own power, and has attachment on screen that prevents clogging with clay, clods, etc.

Machine has elevating capacity of ***one yard per minute,*** and the only operating expense is salary of three men, under ordinary conditions. One operates machine and two break down embankment.

Sand and stone are conveyed 20 ft. away and do not have to be moved. Machine moves under own power. Easily moved from one pit to another. It is all steel, engine enclosed. ***Saves $30 to $50 a day*** in expenses and makes money in handling gravel.

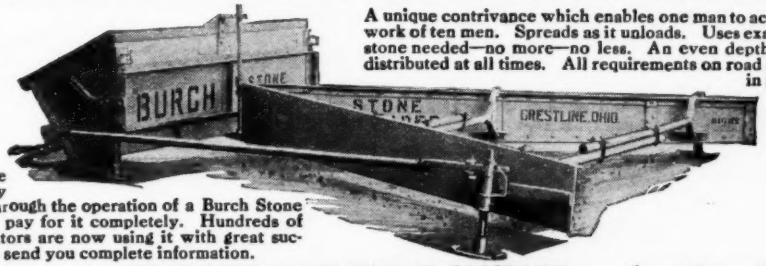
For further particulars write to

THE JORDAN & STEELE MFG. CO., Inc.

CHARLOTTE, MICHIGAN

ONE MAN CAN UNLOAD AND SPREAD STONE SIMULTANEOUSLY

THE BURCH STONE SPREADER



A unique contrivance which enables one man to accomplish the work of ten men. Spreads as it unloads. Uses exact amount of stone needed—no more—no less. An even depth of stone is distributed at all times. All requirements on road provided for in adjustments.

You can save enough in only a few days through the operation of a Burch Stone Spreader to pay for it completely. Hundreds of other contractors are now using it with great success. Let us send you complete information.

Dept. G-4 THE BURCH PLOW WORKS COMPANY, Crestline, Ohio

WM. E. DEE CLAY MFG. CO.

Proprietors of MECCA CLAY WORKS

Manufacturers of

STANDARD AND DOUBLE STRENGTH

Sewer Pipe, Drain Tile, Culvert Pipe, Well Tubing, Flue Lining, Wall Coping and Fire Brick.

WORKS { Mecca, Parke County, Ind., on C. & E. I. R. R.
Newport, Vermillion County, Ind., on C. & E. I. R. R.

Chicago Office, 30 N. LaSalle Street.

ACTUAL COMPARATIVE PERFORMANCE AND COSTS ON ROAD GRADING AND MAINTENANCE WORK IN SEVEN GEORGIA COUNTIES WITH TRACTOR AND TEAM OUTFITS

Counties	Marietta	Macon	Baldwin	Sumter	Houston	Dooley	Lowndes	Total 7
No. of "Caterpillars"	1	1	2	3	1	1	2	11
No. mules previously used	25	34	32	72	16	12	48	239
Investment of tractor & graders	$8,250.00	$8,500.00	$12,450.00	$19,355.00	$5,400.00	$4,960.00	$14,000.00	$72,915.00
Investment of mules, harness & graders	13,350.00	17,020.00	17,200.00	34,490.00	8,280.00	7,440.00	27,140.00	124,920.00
Mi. graded per day	10			15			11	75*
Work days per year	200	240	200	225	200	300	260	162.5
Caterpillar operating cost per day	$39.24	$41.93	$67.04	$94.35	$25.72	$26.43	$79.55	$374.26
Mule equipment operating cost per day	64.02	111.49	113.46	225.13	61.92	37.44	121.49	732.95
Saving per day by caterpillar	24.78	69.56	46.42	130.78	36.20	11.01	41.94	360.69
Saving per yr. (7x10)	4,956.00	16,694.00	9,284.00	29,425.00	7,240.00	3,303.00	10,904.00	81,807.30

*Average.

Brief Analysis of Performance and Costs in the Seven Georgia Counties

Approximate daily mileage.....75 miles
Cost per mile by "caterpillar".....$4.99
Cost per mile by mules..... 9.77

11 tractors replaced 239 mules.

Initial investment tractor outfits $72,915.00
Annual saving effected by tractors 81,807.30

"Caterpillar" outfits paid for themselves in 204 working days.

Additional miles which could be graded with annual saving =

$$\frac{\$81,807.30}{\$4.99} = 16,361 \text{ miles.}$$

Initial investment for mules and equipment $124,920.00
Initial investment for "caterpillar" and equipment..... 72,915.00

Saving on initial investment. $52,005.00

107 counties in State of Georgia own and operate "caterpillar" outfits.

Using Tractors in Hauling Road-Building Material

Where the road is to be concrete or

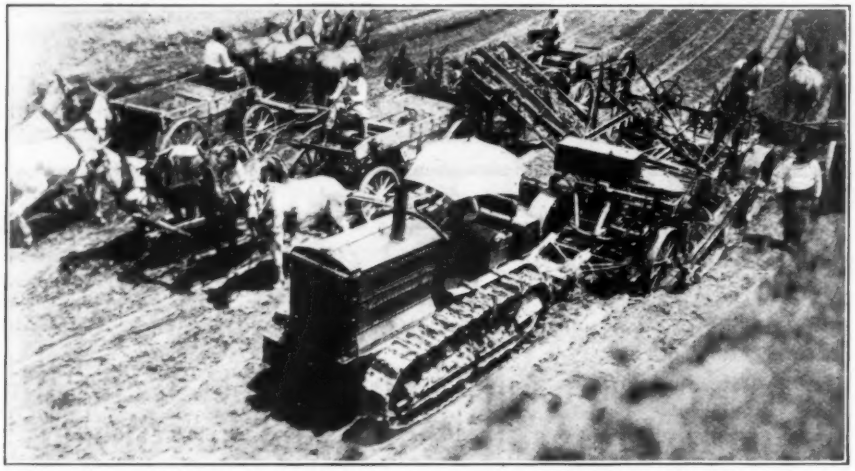


FIG. 4. W. C. MULLEN, OF VICKSBURG, MISS., OPERATING A 10-TON "CATERPILLAR" ON AN ELEVATING GRADER AND AVERAGING 1,350 CU. YDS. PER DAY. CUT RUNS AS DEEP AS 25 FT.

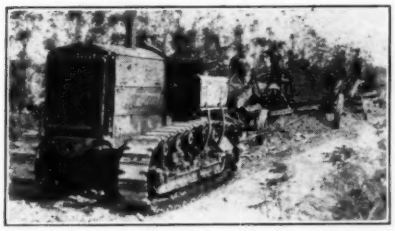


FIG. 5. TEN-TON CATERPILLAR WITH TWO HEAVY BLADE GRADERS.

gravel surface, the "caterpillar" tractor with a train of reversible trailers again plays an important part in transporting the heavy tonnage of road-building material. The method of handling a train of reversible trailers on a narrow roadway is interesting. The tractor pulls the train of loaded trailers up to the stone or gravel already dumped on the subgrade. When the tractor pulls up to the gravel on the subgrade it is uncoupled from the train, turns in its own length, and travels along the side of the trailers to the rear of the train. Here it couples on and backs the train to the gravel already dumped on the grade. The trailer train is then dumped, and the tractor, being on the tail end of the train, takes the train back to the stock pile or storage bin for more material. In this way, as illustrated in Fig. 6, it is unnecessary for the tractor to turn the train of trailers on the roadway. It is possible by this method to work on very narrow roads without inconvenience or lost time, at an extremely low cost per ton mile.

The following data, reprinted from "Engineering and Contracting," on hauling costs, shows the lengths of the different loaded hauls, the tons delivered per day, and the cost per ton mile. The cost data includes such items as interest on the investment, depreciation based on the thousand-day life, labor, gasoline, oil, etc. The record is based on a performance of 18 months, during which time approximately 11,000 tons of material were delivered:

"The Holm Page Co., of Rockford, Ill., began operations about the middle of 1919 on Project No. 7, a stretch of the Peoria road extending 3 miles north and 4 miles south of Henry, Ill. In November, 1919, when they were forced to suspend operations for the year, they had completed approximately 1¼ miles of finished pavement. It so happens on this job that the only available siding was located in the town of Henry. This necessitated a material haul of 4 miles, part of which haul was through a low, swampy section. A 10-ton 'caterpillar' tractor with Troy

FIG. 6. USING TRACTOR AND TRAILER TRAIN FOR HAULING GRAVEL ON A ROAD CONSTRUCTION JOB.

Top:—Pulling up to Gravel Previously Dumped. Middle:—"Caterpillar" Uncouples and Goes to Rear of Trailer Train. Bottom:—Backing Train Preparatory to Dumping Trailers.

trailers was employed to deliver the material to the job.

"In 1920 a 5-ton 'caterpillar' tractor was added to the outfit, which practically eliminated teams on this job. The cuts and fills were very light and the surface was very hard; being an old gravel road, scarifying and grading was done with an Austin Rip Snorter and a 'caterpillar' tractor. With this combination it was possible to scarify approximately 1 mile per day for a 16-ft. road and to keep the grading completed well in advance of the mixer. This work being done under the Illinois Highway Commission's specifications, which allowed only ¼ in. variation in the sub-grade, and being held strictly to this allowance, it was found after some experimenting that to insure uninterrupt-

ed operation of the mixer, correct thickness throughout of the pavement and a firm sub-grade, that the most economical method was to hand-finish the sub-grade, considering the hard gravel surface that had to be finished within ¼ in.

"The sand and gravel were obtained from Chillicothe, Ill., which, being on the same railroad and but 15 miles away, ameliorated considerably the difficulty in obtaining coarse aggregate. The sand and gravel were unloaded with a Byer's auto crane with ¾ yd. bucket into an overhead bin. The 'caterpillar' and trailer train were then loaded by gravity from the bin. It was interesting to note the quantity and hauling cost of the material delivered from the bin to the sub-grade and the method of placing the material for the mixer. To obtain the greatest net load with the least tare weight 8-in. sideboards were put around each Troy trailer. In this manner 5 Troy trailers with sideboards would hold as much as 6 regular trailers, or a net load of 30 tons.

"The following table shows the different lengths of haul, tons delivered per 10 hours, the trip time and the cost per ton mile for the various lengths of haul:

Haul loaded miles.....	1	2	4
Tons delivered 10 hrs.....	390	180	120
Cost per tone mile.....	0.112 ct.	0.105 ct.	0.095 ct.
Trip time	50 min.	1 hr. 25 Min.	2 hrs. 30 min.

"There seems to be some question still in the minds of contractors as to which is the best method of placing material—on the sub-grade, in the ditch or on the shoulders. All methods were employed at the beginning of this job, but finally the gravel was dumped on the one side of the sub-grade and the sand and cement placed on the opposite shoulder.

"This method allows room on the sub-grade for the wheelers to work, avoids congestion and eliminates a great deal of work, which would result if the material had been placed in the ditches, or if the gravel had been placed on the shoulder. Waste is practically eliminated, the gravel and sand shovelers being able to keep the sub-grade and shoulders clean. The wide tires of the trailers smooth and roll the sub-grade.

"The construction methods, being simple and flexible, are facilitated by a complete understanding and co-operation between the contractor and the resident engineer. The work was not handicapped by the necessity of maintaining the road for traffic. This added materially to the uninterrupted progress of the work. Another factor which added materially to the success of this project is the organization which had been perfected by Mr. Frank Miner and Mr. Kirkendall. It is a result of serious thought and contrivance to overcome the ever-present labor question and delivery of material. Every man has a task to do and when he has finished he has a breathing spell. The whole scheme works to the end of having each man see that every other man does his share of the work, with the result that the concrete mixer is going full blast 10 hours a day.

"In the early part of 1920 a small industrial track about 200 ft. long was laid along the shoulder. Small cars with 3-batch boxes, propelled by man power, were used to bring the aggregate from sub-grade to the mixer, where it was dumped in the pan with a small self-propelling crane. With such an outfit it required 41 men on the concrete crew and the highest daily record was 250 ft. of finished roadway. Recently this system was changed, the industrial railway discarded and the aggregate wheeled to the pan. This required placing the gravel on the sub-grade and the sand on the opposite shoulder. This system required 30 men, including a superintendent, distributed as follows:

"2 men on the tamping machine, 2 men at the spout, 1 engineer, 1 fireman, 2 men carrying cement from the stock pile, 1 man dumping cement into the pan, 4 men wheeling gravel, 8 men shoveling (2 for each gravel wheeler), 2 men wheeling sand, 2 men shoveling (1 for each sand wheeler), 2 men bringing up forms and placing them in advance of the mixer, 2 men covering up the green concrete with each and sprinkling.

"Each man has a very definite task to perform, and with such an arrangement the daily average is 415 lin. ft. per day, or 738 sq. yds. of finished concrete. The aggregate is mixed in a 4-bag batch Foote mixer. It is mixed for 1 minute, the time being regulated by a batch meter on the mixer. The mix on this project is 1:2:3½. Two men set the necessary 660 lin. ft. of forms per day.

"The Lakewood finisher requires but two men for the complete operation and easily finishes the daily output of this organization.

"The concrete is 16 ft. wide, 7 ins. thick at the sides and 8 ins. thick at the center.

No expansion nor reinforcing whatever are used. At construction joints a ½-in. opening is left and later filled with tar to insure a smooth, sound cohesion between the old and new work.

"The labor situation in this vicinity, while it is not serious, is a very vital factor. At the present time labor at 50 cts. per hour, with board at $1 per day, is just sufficient to keep the job moving.

"The cost data contained herewith includes labor, fuel, oil, interest on investment, depreciation on equipment, repairs, maintenance, etc.

"The personnel handling the work on this job are: Frank Miner, General Manager for Holm Page Co.; Gene Kirkendall, Superintendent; E. B. Blough, Resident Engineer for Illinois Highway Commission."

the economy of the "caterpillar" tractor for maintenance.

The cost of maintenance varies with the different types of road, but with speed and power for a maximum mileage of maintenance, the cost is reduced to a minimum. In this connection the report from Sumter County, Georgia, is of interest. In this county the 5-ton "caterpillar" is being used for road maintenance, and pulls what is called a three-way maintainer, which is a gang of drags that covers the whole road at one operation. With the power and speed of the 5-ton "caterpillar," Sumter County can single-drag 30 miles or double-drag 15 miles of road in a day. The report shows that during the 10 months they have operated this tractor, the cost for repairs has been approximataely $27. The daily operating

FIG. 7. "CATERPILLAR" TRACTOR PULLING ROAD MAINTAINER IN SUMPTER COUNTY, GEORGIA.

The figures in the above report have been checked and approved by the contractors who did the work.

Tractors on Maintenance Work

Having completely and successfully handled every operation of building an earth road with tractors, this money and effort spent is all in vain unless they are properly maintained. Here again the tractors meet the most important obligation to the community. Proper maintenance means action and speed over many miles of road in the shortest possible time. The roads must be dragged or leveled off when they are still wet—before the sun dries out the tops of the hills and leaves only dust to fill the ruts.

Fig. 7 illustrates the Sumter County operation. On this class of work the speed of 3 miles per hour with power to handle the work effectively has proven cost, the cost of the same work when formerly handled by mules, and the daily savings effected are shown in the detailed report as follows:

DAILY COST OF OPERATION OF 5-TON CATERPILLAR TRACTOR DOING WORK OF 16 MULES IN ROAD MAINTENANCE WORK IN SUMTER COUNTY, GA.

Investment in tractor	$4,150.00
Investment in maintainer	370.00
Total investment	$4,520.00
Daily interest on investment, 7% per annum and 225 days per year	$ 1.40
Daily depreciation on tractor and grader, based on 20% per annum and 225 days per year	4.02
Wages of engineer	4.00
Wages of maintainer man	2.50
Board of 2 men, $1 each	2.00
Repairs	2.00
27 gal. gasoline at 29c	7.83
¾gal. motor oil at 66c	.50
¼ gal. trans. oil at 72c	.18
2 gal. track oil at 20c	.40
2lbs. grease at 12½c	.25
Total daily cost	$25.08

16 mules and 8 drivers—outfit necessary to do the work of 5-ton "Caterpillar" on maintenance work. Daily cost of operation:

Investment 16 mules at $400 each	$6,400.00
Investment maintainer	370.00
Investment 8 sets double harness	560.00
Total investment	$7,330.00
Daily interest on investment based on 7% per annum and 225 days per year	$ 2.28
Daily depreciation on mules, $6,400, based on 15% per annum and 225 days per year	4.26
Daily depreciation on maintainer and harness, based on 20% per annum and 225 days per year	.82
Wages of 8 drivers, $2.50 each	20.00
Board of 8 men, $1 each	8.00
Feed for 16 mules at $1.78 each	28.48
Shoeing mules and repairs on harness	1.00
Total daily cost	$64.84
Daily cost of 16-mule outfit	$64.84
Daily cost of 5-ton "Caterpillar" outfit	25.08
Daily saving with 5-ton "Caterpillar"	$39.76

It is interesting to note the variety of operations on road construction which can be handled economically with a tractor which is designed and built to meet the requirements of road building, a variety of speeds to meet the different soil conditions, and with traction to assure the guaranteed drawbar horse power.

FIRE AT WINTHROP HARBOR PLANT WILL NOT HANDICAP AUSTIN MACHINERY CORPORATION

The fire in the Winthrop Harbor (Ill.) plant of the Austin Machinery Corporation on March 22, while extensive at this plant, will not, according to officials of the corporation, in any way interfere with production and prompt delivery of Austin trenching machines, backfillers, building mixers, pavers, draglines and shovels, as practically all lines of Austin machinery are also being built at the plants at Muskegon, Mich., as well as at the former plant of the Toledo Bridge and Crane Company at Toledo, O.

President B. A. Linderman immediately arranged for the plants at Toledo and Muskegon to increase their stock production orders to take care of the shortage which would otherwise occur through the loss of the Winthrop Harbor plant.

The fire at the Winthrop Harbor plant completely destroyed the "unfinished stock" warehouse and store rooms; both the trenching machinery assembly and paving mixer assembly buildings, and a number of machines on which assembly was practically completed; but the fire did not reach the "finished machines" warehouses and, fortunately, a number of machines had just been loaded on cars for shipment and were saved.

The plants at Muskegon and Toledo are fully equipped for turning out all standard and special machines in quantity, patterns of all kinds being protected in duplicate, and all of the popular sizes of Austin construction and public service machinery are under construction at more than one plant.

The Austin Machinery Corporation advise they have on hand in Muskegon and at Toledo, ample stocks of wagon loaders, the popular sizes of trenching machines, backfillers, mixers, pavers and ½-yd. and ¾-yd. draglines and shovels, and that a new lot of 1-yd. shovels and draglines are now coming through the Toledo plant.

NOVEL METHOD OF STOPPING OVERFLOW OF CESSPOOL

On the grounds of the suburban residence of Mr. Winterson near Annapolis, Maryland, was a cesspool 8x8x8-ft. that frequently filled to the top and overflowed, saturating contiguous ground on one side.

It was walled up with dry placed stone to within 2 ft. of the surface of the ground. It was located at the head of a slope. One hundred feet down the hill the surface of the ground was lower than the bottom of the cesspool.

It was decided to try stopping the overflow by making the soil more open or absorbent. This was accomplished by a method new to this locality.

A row of 2-in. bore holes, 12 in number and 10-ft. deep and 6 ft. apart, was put down leading away from the cesspool in the direction of the low ground.

Each hole was loaded with a pound of 40 per cent ammonia dynamite, thoroughly tamped; holes connected up in series and fired with electric blasting caps.

The theory was that the blasts would break up the hard soil, make it more absorbent and that the liquids in the cesspool would sink into the ground rapidly enough to avoid any overflow at the top.

The work was done in February, 1920. Two days afterwards, the level of the fluid mass in the pool had gone down 4 ft., and notwithstanding it has been in continuous use since, it had not risen above that level in October of the same year.

The total cost of the job was $24.50. Two men did the work in four hours.

PATENTED PAVEMENTS PERMISSIBLE UNDER DECISION OF ILLINOIS SUPREME COURT

Under decision handed down by the Supreme Court of Illinois in February, 1921, an act passed in 1919 by the Illinois State Legislature regarding patented pavements is declared constitutional. Prior to that year, the use of patented pavements by the several cities of the state had been prohibited under the Supreme Court's decision of the then existing law. The Legislature then passed an act permitting municipalities to contract for patented pavements, provided they are placed in competition with unpatented pavements.

Pursuant to this, the city of Rockford, Ill.. received proposals for several types of pavement, including Warrenite Bitulithic, patented by Warren Brothers Company, Boston.

A taxpayer, R. J. Schultz, brought an action to restrain the contract on the grounds that the act of 1919 was unconstitutional and that the proceedings had not fully complied with the act. The Supreme Court, in unanimous opinion, written by Mr. Justice Carter, decides against the plaintiff taxpayer on all points and sustains decision rendered by the county court more than a year ago.

This case, now finally disposed of, has been in the courts for nearly two years, and is of interest not only to the state of Illinois, but to other states.

Contracts Awarded

ROADS AND STREETS.

Ala., Mobile—Hancock Bros. and E. B. Toulmin, award. contr. for paving 4.7 mi. Old Shell Rd. and graveling Hall's Mill Rd., at $141,530.32.

Ariz., Phoenix—State Hwy. Dept. let contr. for paving 8.8516 mi. Tucson-Nogales Hwy., Sec. A, 18 ft. wide, FAP 29, to J. L. Hoopes, Miami, at $305,-616.

Ariz., Phoenix—J. L. Hoopes, Miami, Ariz., award. contr. for contr. of Tucson-Nogales Hwy., Sec. "A," 18 ft. pavement, at $162,510; state to furnish material at cost of $96,821.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick Street, Los Angeles, award. contr. for constr. 7.65 mi. conc. hwy. in Road Imp. Dist. 14, at $298,000.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick St., Los Angeles, award. contr. for paving 7.562 mi. hwy. (China grade) in Rd. Impvt. Dist No. 10, Kern Co., at $345,000.

Cal., Bakersfield—Bakersfield Engrg. Co., award. contr. for paving 21st St., (abt. 136,000 sq. ft.) with 5-in. Willite at 26½c ft.

Cal., Calexico—Geo. H. Oswald, Los Angeles, award. contr. for approx. 13 mi. conc. sidewalks, 5 ft. wide, with same mileage of conc. curb and cross walks at each street intersection, at $250,000.

Cal., Sacramento—Contracts for state highway work award. on projs. as follows: Fairchild-Gilmore-Wilton Co., Pacific Electric Bldg., Los Angeles, contr. for paving 14.6 mi., Kern Co., betw. Las Cruces and Zata Sta., at $201,185; Guy F. Atkinson, Portland, Ore., award. contr. for paving 12 mi. Fresno Co. betw. Oil King Sch. and Huron Rd., at $252,746; Bates & Borland, Oakland Bank of Savings Bldg., Oakland, contr. for paving 8.1 mi. Fresno Co. at $109,874; Henry J. Kaiser, Seattle, Wn., contr. for paving 15.6 mi. Shasta Co., at $292,286; also contr. for paving 13.6 mi. Tehama Co., at $182,043. Minimum specfs. for paving on all these projs. is 5-in. conc., reinforced.

Cal., Mill Valley—S. P. Brownlee, award. contr. by Council for road work in Tamalpais Park, at $50,000. Other new rd. impvts., costing $300,000, will be started in county within next 30 days.

Cal., Oakland—Bates & Borland, Oakland, award. contr. to constr. conc. hwy. from Alameda Co., Niles to Newark, at $184,745.

Cal., San Diego—Bent Bros., Central Bldg., Los Angeles, award. contr. for paving 10.12 mi. Bellena-San Julian Rd., 18 ft. wide conc., at $291,419.

Colo., Denver—State Hwy. Dept. Denver let

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contr. for grading and draining 6.847 mi. Muddy Crk. Rd. above Kremmling 28 ft. wide, F. A. P. 75, Grand Co., to Hinman Bros., Kremmling, at $22,235; 4.884 mi. rd. betw. Victor and Cripple Crk., 20 ft. wide, F. A. P. 52, Teller Co., to E. H. Honnena, Colo. Springs, at $23,817; 1,748 mi. rd. betw. Colo. Springs and Canon City, 28-ft. wide FAP 47, El Paso Co., to Pickering Bros., Salt Lake City, at $21,663; grading, draining and gravel surfacing 3.504 mi. betw. Wray and Schramm, 28 ft. wide, F. A. P. 40, Yuma Co., to E. Lindsey, Denver, at $22,350; paving and draining 2.727 mi. Morgan-Brush Rd., 18 ft. wide, FAP 38, Morgan Co., conc., to La Nier-White Co., Ft. Morgan, at $68,613; grading and surfacing .758 mi. rd., 28 ft. wide; also bldg. brdg. over Platte River betw. Lake George and Divide, to have two 40-ft. spans, FAP 112, Park Co., to J. R. Donaghy, Pueblo, at $21,046; paving and draining 1.334 mi. rd. from Boulder eastward, 18 ft. wide, FAP 87, Boulder Co., involving 14,092 sq. yds. conc., to A. Doble, Poplar and North 2nd Sts., Sterling, at $42,232.

Del., Smyrna—Stange & Allen, Washington, D. C., award. contr. for constr. of 3.41 mi. hwy. thru Smyrna for Delaware St. Hwy. Dept., at $222,479.

Fla., Perry—Hutton Engrg. & Constr. Co., Savannah, Ga., award. contr. to pave streets, etc.; 37,000 sq. yds. $200,000 available.

Fla., Lake Worth—W. B. Eckler, West Palm Beach, Fla., award. contr. to constr. conc. rein. block sidewalks. $125,000 available.

Ill., Chicago—County Board let following contrs. to constr. 5 stretches of roads in Cook County: ½-mi. stretch, known as Maywood Road, let to H. C. Goeltz & Co., at $19,000; Des Plaines River Rd. let to Ready & O'Callaghan Coal Co., at $176,601; W. 111th St., impvt., to Bronger & Black, at $319,175; Glen View Rd., to Ready & O'Callaghan Coal Co., at $112,482; Hans Blase, contr. for Touhy Rd. at $209,736.

Ind., Connersville—Keer & Murphy, Bloomington, award. contrs. for paving 3 mi. Laurel Rd. with 2-course conc. at $105,948; graveling 3 mi. Bentonville Rd. to Conner, Jenks & Bierley, at $43,845.

Ky., Glasgow—R. B. Tyler Co., Louisville, Ky., award. contr. for 11 mi. Kentucky rock asph. paving in Barren Co., at $469,000.

Ky., Hawesville—Hancock Constr. Co., award. contr. for 13½ mi. Ohio River Rd., at $120,000.

Ky., Williamstown—Connel & Brecht, award. contr. for 1 mi. rd. in Williamstown and 3 mi. bet. Williamstown and Dry Ridge, at $174,000.

Md., Snow Hill—Piel Constr. Co., award. contr. for 3.62 mi. conc. rd., Worchester Co., at $133,312.

Mich., Ionia—Schnieder & O'Harrow, Lowell Mich., award. contr. for graveling, drng., structs., and surfacing to width of 12 ft. with gravel, at $71,850.

Minn., Grand Rapids—A. Guthrie & Co., 336 Jackson Street, St. Paul, award. contr. for over 27 mi. of rd. from Grand Rapids to St. Louis Co. line east of Keewatin sub-grade, at $415,517.

Minn., St. Paul—Fielding & Shepley, 216 University Ave. St. Paul, award. contr. for paving White Bear Rd.—city limits to White Bear Lake—at $329,966.

Miss., Woodville—Bass Constr. Co., Hazlehurst, Miss., award. contr. for 10.5 mi. State Trunk Rd. betw. Woodville and Natchez, at $71,137.

Miss., Tupelo—Mills Elec. & Constr. Co., McComb, Miss., award. contr. for 16 mi. conc. rd. east and west thru Lee Co., at $310,000.

Neb., Omaha—Jas. J. Parks Co., Omaha, award. contr. for paving Dodge St., at abt. $80,000. 200,000 sq. yds. vitr. brk. blk.

N. J., Belvidere—Bd. Freeholders Warren Co., will pave 12 mi. Phillipsburg-Port Golden Rd., conc. by Day Labor, abt. $600,000.

N. C., Greensboro—Jameson Bros., Raeford, award. contr. by State Hwy. Dept. for bldg. 12 mi. topsoil rd., Stokes Co., at $61,453; 2 bridges and culverts on rd., to Rogers & Shumway, Petersburg, Va., at $37,204; 7 mi. topsoil rd. to Chandler & Ragland, Virgilina, Va., at $31,655; 2 brdgs. to Hagerdron Constr. Co., Commerce, Ga., at $24,462.

N. C., Hertford—F. J. McGuire, Norfolk, Va., award. contr. to constr. asphalt streets here, at $75,000.

N. C., Jefferson—Callahan Constr. Co., Knoxville, Tenn., award. contr. to grade and surface 80 mi. of roads with sand and gravel. $500,000 available.

N. C., Washington—P. G. Ligon, 2000 Brookfield Ave., Baltimore, Md., award. contr. for impvt. various sts., at $421,176.

N. M., Clovis—New Mexico Constr. Co., Albuquerque, N. M., award. contr. for Warrenite-Bithulithic paving here, at $220,000. This previously reported to have been award. to Clark & Henery Constr. Co., San Francisco.

N. M., Sante Fe—L. V. Stryker Constr. Co., Denver, Colo., award. following rd. and brdg. contracts: Proj. 1-C, Colfax Co., $64,762.04, exclusive of 10% for engrg. & contingencies; Proj. No. 50, Luna Co., $61,781 and Proj. No. 51, Socorro Co., at $56,933; Lee Moor Contr. Co., El Paso, Tex., award. contr. for Proj. 27, El Paso, at $153,250 and Dan La Roe, Palestine, Tex., contr. for Proj. No. 29, Eddy Co. All bid prices named are exclusive of 10% for engrg. and contingencies.

O., Columbus—G. Sheridan, Columbus, awarded contr. for grading bldg. brdgs. and culvts. and paving 2.2 mi. Ohio-Sandusky Rd., 50 ft. wide, Franklin Co., brick, at abt. $338,000.

O., Pt. Clinton—Bert Pettibone & J. Fred Graves, Lakeside, award. contr. for bldg. 7 mi. rd. betw. Oak Harbor and Pt. Clinton, at abt. $200,000.

O., Toledo—Contracts for impvt. of rd. to cost approx. $640,000 award. as follows: Hill Ave. to LaBoiteau & Huger; Douglas Rd. to Warren & McKechnie; Starr Ave. to Tom Garrigan; Clinton St., to Warner & McKechnie; Brint Rd. to Thomas Constr. Co. and South Ave. and Bryce Rd. to Russell & Jennison.

Okla., Ardmore—Maney Bros., 304 Empire Bldg. Okla. City award. contr. for graveling 16 miles of road, 18 ft. wide, at abt. $340,000.

Okla., Walters—Wichita Falls Constr. Co., Wichita, Tex., award. contr. for paving various streets, 26-60 ft. wide, 2-in. asph. conc. on 5-in. conc. base, at abt. $470,000.

Pa., Harrisburg—Frank J. Groman & Sons, Bethlehem, award. contr. by State Hwy. Dept. for imp. of sect. of rd. connecting Boylestown and Easton, at $359,351. Project calls for constr. of 34,871 ft. one-course rein. conc. roadway, 18 ft. wide.

Pa., Harrisburg—Conner & Ley, Philadelphia, award. contr. for constr. of 11,374 ft. conc. roadway on Route 281, Bensalem Twp., Bucks Co., at $143,854.

Pa., Harrisburg—Vincenzo Di Francesco, Llanerch, Pa., award. contr. by State Hwy. Dept., for project planned for Route 133, Upper Darby and Haverford Twps., Delaware Co., where 12.077 ft. one-course rein. conc. will be laid. His bid was $118,429.

Pa., Wilson—Kavanaugh-Denivo Constr. Co., Youngstown, O., award. contr. for grading, paving, curbing, sewering, etc. 4,600 ft. on State Street, at $127,480.

S. C., Moncks Corner—J. C. Fairy, Orangeburg, S. C., award. contr. for 16 mi. Charleston-Monocks Corner Rd., at $101,000.

Tex., Amarillo—Potter County let road contracts as follows: Willite Constr. Co., Houston, Tex., $280,000, pave 16 mi.; Standard Constr. Co., Dallas, $239,000, pave 12 mi.; McKnight & Haymer, Amarillo, gravel hauling.

Tex., Dallas—Contracts for constr. of Millers Ferry Paved Rd. from Dallas to Wilmer and Hutchins, and for constr. of Denton Rd., award. as follows: Hill, Wilson & Watson, grading & surfacing; Texas Rd. Co., for paving; Jackson & Goods for bridging. Total cost on each road approx. $440,000.

Tex., Denison—Edward C. Baum, Durant, Okla., award. contr. for constr. of 40,000 sq. yds. rein. pavement, $200,000 available.

Tex., El Paso—El Paso Bitiluthic Co., Piedras St. award. contr. for grading, draining and paving 15.45 mi. Alamogorda Rd., State Hwy. 33, at $527,170, including 10 per cent for engrg. and contingencies.

Tex., Kingsville—Road contr. let as follows: A. C. Buchanan & Son, Temple, Tex., draing., structs., at $17,201; W. T. Montgomery, San Antonio, Tex., $112,860, surface 18.6 mi. Hwy. No. 12.

Tex., Wichita Falls—Prentice & Potts, awarded conc. pavement, $200,000 available.

Va., Staunton—Carpenter, Major Bros. & Co., Clinton Forge, Va., award. contr. to constr. 20 mi. waterbound macadam and penetration macadam rd. $250,000 available.

Wash., Seattle—S. A. Moceri, award. contr. for paving 1st Ave., North, et al, at $27,174; Puget Sd. Bridge & Dredging Co., award. contr. for filling and grading First Ave., So., at $88,422; Independent Asphalt Paving Co., award. contr. to furnishing 21,000 tons rock riprap for Alki Ave. seawall, at $2.45 per ton.

Wash., Tacoma—T. M. Morgan, Everett, award.

contr. for grading 3.47 mi. National Park Hwy. from Forest Reserve line to park entrance, at $88,-420; D. W. Rutherford, Tacoma, award. contr. for grading 1.43 mi. Purdy-Kitsap Co. line rd. at $15,-831.

Wash., Yakima—Independent Asphalt Paving Co., Yakima, award. contr. for paving 4.3 mi. Grandview Orchards Tract Rd., involving 43,900 sq. yds. 6-in. conc., at $124,418.

W. Va., Moundsville—Marshall County let contr. for rd. constr. as follows: Kelley Constr. Co., Clarksburg, W. Va., 3 miles Cameron-Poplar Spgs. Rd., $110,000; $22,000, Green Valley Rd. Cameron Dist., conc. surface; Berry, Spriger & Ridgeley, at $33,000, grade and drain rd. Meade Dist.

W. Va., Wheeling—Contracts let to H. L. Seabright, Coss & Otto and P. J. Gilligan, all of Wheeling, to pave 4 or 5 streets at Woodsdale; brk. and asph. $100,000 available.

Wis., Green Bay—Gruenke Bros., Appleton award. contr. for improving 2.35 mi. Appleton Dale-Medina Rd., F. A. Rd., FAP 232, Outagamie Co., at $89,-166; 3.67 mi. Sheboygan-Manitowoc Rd., FAP 255, Manitowoc Co., to Zandala Cement Co., Manitowoc, at $122,769.

Wis., Elkhorn—Geo. Welch, Beloit, award. contr. for Delavan-Darien Rd., at $101,507.

Wis., Menomonie—A. Larson & Co., Eau Claire, award. contr. for Eau Claire-Menomonie Rd., FAP 127, at $137,194.

Wis., Waukesha—Following contrs. let on road work: East Troy-Mukwonago Rd. to Universal Engrg. Co., 318 S. Barstow, Eau Claire, at $37,-231; Hartland-Nashotah Rd., to Jno. O'Gara, 133 W. Washington St., Chicago, at $148,446; Milwaukee-Prospect Rd. and Waukesha-Genesee Rd. Low, Jno. O'Gara, $171,927; $140,034, Watertown-Plant Rd., low, R. R. Birdsall, Racine, at $68,200.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Long Beach—Leo Miletich, 610 W. 54th St., Los Angeles, award. contr. for constr. of nearly 10 mi. cem. pipe sewer laterals in E. Long Beach, at $76,423.

Cal., Patterson—W. J. Schmidt, Berkeley, award. contr. for sewer system here, at $52,499.

Cal., Stockton—Shutes & Zinok, and Goold & Johns, Stockton, award. contr. for constr. of south outfall sewage disp. plant for city, at $105,532.75.

Cal., Yosemite—It is understood that the Schultz Constr. Co., Maskey Bldg., San Francisco, will be award. contr. at abt. $100,000 on an altern. bid for constr. of sewage disp. system in Yosemite National Park.

Colo., Denver—J. V. Stryker, 1507 Blake St. award. contr. for bldg. storm sewers, manholes and inlets in 20 mi. N. Denver Storm Sewer Dist. No. 2, at $387,731.

Washington, D. C.—P. G. Ligon, 2000 Brookfield Ave., Baltimore, award. contr. for constr. of storm sewers and impvt. of streets. Total cost of work $390,000.

Ga., Cochran—The J. B. McCrary Co., Atlanta, award. sewerage contr. amounting to $30,000.

Ill., Elmhurst—Gedney & Murphy, Minneapolis, Minn., award. contr. for constr. of sys. of vitr. tile pipe and vitr. tile segment blk. sewers with sewerage disp. plant, at $325,000.

Ill., Macomb—Harry Holmes, City, award. contr. for constr. of White Street sewer system, at $20,-858. Sewer is about 32 blks. in length. Bids called for 13,596 ft. sewer pipe; 29 manholes and 24 ft. cast iron pipe all to be in place.

Ind., East Gary—Tirtilli & Scully, 418 Spruce St., Chicago, award. contr. for bldg. 9,397 lin. ft. 10-27-in. vitr. sewer in Sewer Dist. 1, at $41,977.

Ind., Indianapolis—Sheehan Coal Co., 207 Holliday Bldg., awarded contr. for bldg. 3,065 ft. sewer in Dakota St., Ray to Palmer Sts., involving 3,065 ft. 30-in. rein. conc. and 360 ft. 20-in. vitr. pipe, at abt. $43,000.

Ind., Richmond—Jones Constr. Co., Connersville, Ind., award. contr. for constr. of sch. bldg. at $24,-918.

Ia., Charles City—Ward & Weighton, award. contr. for disposal plant, at $128,331. Includes connecting sewers with 16-in. cast iron pipe siphon, at $23,894; purifying sta. and 2,000 ft. 12-in. cast iron pipe, centrif. pump and motor, $22,438; disp. plant 30x100 tanks and filters, $85,743. Contrs. located at 516 Davidson Bldg., Sioux City.

...ns., Cha... City let contr. for bldg. san. sewerage system in various streets to Langston & McSweeney, Springfield, at $46,723.

Detroit, Mich.—R. D. Baker, Penobscot Bldg., award. contr. for bldg. Benieau Ave. sewer arm, at $123,448.

Neb., Crete—Allied Constr. Co., 304 Bee Bldg., Omaha, awarded contr. for storm sewer in Storm Sewer Dist. No. 1, at $61,578.

Neb., Minatare—J. S. Schwartz, Colo. Springs, Colo., award. contr. for sewer system plant, main and alt. sewer districts, at $61,000.

N. J., Freehold—Jos Miele & Co., E. Orange, award. contr. for constr. of storm drain and appurts. for central sect. of Boro., at $22,340. Work includes 48-in., 42-in., and 36-in. rein conc. pipe storm sewer with catch basins and appurts.

N. J., Phillipsburg—Korp & Korp, award. contr. for bldg. 3 sects. of new sewer system, at $46,255.

N. C., Durham—Dysard Constr. Co., Atlanta, Ga., award. contr. to constr. 10,000 ft. 8-in. san. sewers and 9,300 ft. 6-in. sewers; $27,780 without pipe. M. E. Newsom, Mayor, H. W. Kueffner, City Engr.

N. C., Gastonia—Tucker & Laxton, Charlotte, award. contr. to constr. filter plant with 2,000 gal. capy. every 24 hrs., rein. conc. bldg., at $91,000.

N. C., Goldsboro—West Constr. Co. Kinston, award. contr. for improving various streets and extending sewerage system at abt. $50,000.

O., Columbus—Ames Bros., 72 West 4th Ave., award. contr. for excavating and bldg. 14,242 ft. 6-20 in. lat. sewers in various streets of Shepard here, at $33,561; H. E. Miller Constr. Co., Columbus, award. contr. for bldg. sewers in Summit St., at $7,708; Maysfield St., to J. G. Clifford, at $8,494; alley west of Taylor Ave., to Ames Bros., 72 West 8th St., at $11,137.

O., Toledo—A. Bentley & Sons, Toledo, award. contr. for a substruct. of pumping station, at $274,-800.

Okla., Norman—Foster & Skaer, Wichita, Kans., award. contr. for bldg. sewerage system, involving 11,000 ft. 15-in. and 1,775 ft. 18-in. tile sewer, at $31,675.

Okla., Walters—Wichita Falls Constr. Co., Wichita, Tex., award. contr. for bldg. storm sewers in various streets, at abt. $80,000.

S. D., Sioux Falls—Fanebust Bros., Sioux Falls, award. contr. for lat. sewer, at $13,500.

Tex., Dallas—R. J. Estep & Co., award. contr. for constr. of Cedar Creek san. sewer to serve southern sections of Oak Cliff, at $78,362.

Tex., Ft. Worth—Tarrant Constr. Co., Ft. Worth, award. contr. for bldg. 42x45 ft. 30-84 in. conc. sewer in Carson and Mimosa Sts., at $75,257; 5,365 ft. 12-72 in. rein. conc. sewer in 14th and Boulevard Sts., 4,400 cu. yds. earth, 1,000 cu. yds. loose and 1,000 cu. yds. solid rock trenching, etc. to General Constr. Co., Burton Bldg., at $38,331.

W. Va., Martinsburg—P. Flanigan & Sons, Hartford Rd. and Balt. & O. R. R., Baltimore, award. contr. for bldg. 12,000 ft. conc. and tile sewers in various streets, at abt. $30,000.

WATER SUPPLY AND PURIFICATION.

Ala., Montgomery—Layne & Bowler Co., Chelsea Avenue, Memphis, Tenn., award. cont. for bldg. 4 deep wells, with minimum capy. 4,000,000 per day, at abt. $100,000.

Cal., Arcadia—Lacy Mfg. Co., Washington Bldg., Los Angeles, award. contr. for furnishing and laying 19,000 ft. 8-14-in. riveted steel pipe for water works system, at abt. $32,000.

Ky., Berea—Moynahan & Forbes, Richmond, Ky., award. contr. to constr. dam and storage reservoir at abt. $40,000.

Ind., Indianapolis—R. A. Scott, 543 N. Temple Ave., award. contr. for excavating abt. 50,000 cu. yds. earth and gravel for one million gal. reservoir, at $35,450.

Ia., Cedar Rapids—Loomis Bros., 319 Third St., award. contr. for repairing and improving pumpstation on Second St., N. and Division St., at abt. $30,000.

La., Shreveport—Douglas & Anderson, Shreveport, award. contr. to constr. 80x50-ft. brk. store and steel fireproof pumping house, at $95,850; W. K. Henderson Iron Wks., Shreveport, constr. to install 10-ton crane inside pump-house, at $2,300; U. S. Bast Iron Pipe and Foundry Co., Birmingham, Ala., to furnish pipes and specials, at $53,253; Ludlow Valve Co. Troy, N. Y., for 2-ft. check and gate valves, at $3,557 Rensselaer Valve Co., Troy, gate and check valves at $1,943; H. A. Forrest, New

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Barber Asphalt Co.
Bitoslag Paving Co.
The Barrett Co.
New Orleans Refining Co.
Pioneer Asphalt Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Bitoslag Paving Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Railroad Plants.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Surface Heaters.
Barber Asphalt Paving Co.

Asphalt Tools.
Barber Asphalt Paving Co.
Warren Bros. Co.

Asphalt Tool Wagons.
Barber Asphalt Paving Co.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Barber Brand Cold Repair Cement.
Barber Asphalt Paving Co.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Bermudez Road Asphalt.
Barber Asphalt Paving Co.

Binders, Road.
Barber Asphalt Paving Co.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Bodies.
Lee Loader and Body Co.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.
Pan-American Bridge & Construction Co.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement, Portland.
Portland Cement Association.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Lakewood Engineering Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Samuel A. Greeley.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Shields, W. S.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Lakewood Engineering Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Crushed Stone.
Cleveland Stone Co., The

Culvert Molds.
Austin-Western Co., Ltd., The
Storms Mfg. Co.

Culvert Pipe, Cast Iron.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Curbing, Sandstone.
Cleveland Stone Co., The

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Orleans, La., contr. to trench, lay and place water pipe, at $19,278.

Minn., North Branch—Hedberg Boise, 2208½ West 2nd. St., Duluth, award. contr. for bldg. water works system, at $33,174.

Minn., Rush City—Gedney & Murphy, 613 Globe Bldg., St. Paul, Minn., award. contr. for wells and suctions mains, at $41,125.

Miss., Pascagoula—J. B. McCrary Engrg. Corp., Atlanta, Ga., award. contr. to constr. water supply and electric light plant and power house; also install water and elec. lighting system. $61,600.

Mo., Moberly—Lynch McDonald Constr. Co., award. contr. to improve water works; constr. dam, spillway and intake well, erect power house, fiter plant, chem. storage house and pumping station at dam, all of brick constr.; install 4-unit 2,000,000-gal. rapid sand conc. filter plant, 4 centrif. pumps, condensing pumping engine, etc., at total cost $350,000.

N. Y., New York City—P. J. Brennan & Son, 624 Madison Ave., N. Y. C., awarded contract (general) for sewers, water mains, etc., at site of new public schools, at $869,000.

Ohio, Idlewood (Cleveland P. O.)—D. Pfahl Guardian Bldg., Cleveland, award. contr. for laying 1,200 ft. 4-16-in. cast iron water mains in Belvoir Blvd.—Cedar Road to south corp. line—at $51,481.

Ohio, Euclid—Village let contr. for laying water mains in Midland Road, Ivan and Newman Aves., to A. C. Hattendorff, 1061 6th Ave., E. Cleveland, at $11,395; Nicholas Ave., to J. B. Lynn, Lampson Rd., Cleveland. $11,923; Tracy Ave., to Iafornaro & Co., Murray Hill Rd., Cleveland, at $2,885.

Ohio, So. Euclid—Village let contr. for laying 9,740 ft. 4-16-in. cast iron water mains in Mayfield Rd., to T. Marro, Illuminating Bldg., Cleveland, at $73,741; 8,250 ft. 4-16-in. c. i. water main in Belvoir Blvd.—Mayfield to Cedar Rds.—to A. Marra, at $64,549.

Ohio, Toledo—A. Bentley & Sons, Toledo, award. contr. for a substruct. of pumping station, at $274,800. Bids will be readvertised for superstruct. and equipt.

Ohio, Wickliffe—Gantos Constr. Co., Columbia Bldg., Cleveland, award. contr. for laying water mains in Spring Rd. to Hillcrest, Oakdale, Thrush, Elm, Robindale and Maple Avenues, at $32,472; Ryde Rd. and Mosher Avene to Post Constr. Co., 343 The Arcade, Cleveland, at $48,429.

Okla., Wynona—M. L. Cunningham, Empire Bldg., Okla. City, award. contr. for bldg. water works and sewerage systems, involving 6-8-in. Cl. B cast iron mains and 40,000 ft. 8-12-in. vitr. sewers, at $272,322.

Tex., Mineral Wells—Tibbets & Pleasant, Okmulgee, Okla. award. contr. to complete 1,500,000-gal. plant; contr. 4½ mi. 12-in. case iron pipe line, 2 pump stations and equipt.; fiter basins and power line; install four 750 G. P. M. pumps and 4 75 h. p. motors, at total cost of $200,000.

Prospective Work

ROADS AND STREETS

Ala., Birmingham—Extension of paving on 8th Ave. No.— present end of paving at Walker, or 6th St. to 19th St. and Ave. E, Ensley, thru Graymond and Owento, will begin as soon as Ord. providing for proj. is put thru. Est. cost $300,000; type, Bitulithic. Extension will be built from curb to curb and sidewalks built at same time.

Ala., Birmingham—Jefferson County will surface Rocky Ridge, Adger and Oak Grove Rds., with chert. $80,000 bonds sold. D. C. Ball, Pres. Bd. of Revenue.

Ala., Montgomery—State Hwy. Comn., approved project in Lauderdale Co., costing approx. $106,000. Douglas Co. will furnish $40,000.

Ark., Fort Smith—News received from Washington by officials of Ft. Smith Rd. Dist. and Sebastian Bridge Dist. of allotment of $12,000,000 to Arkansas for bridge and hwy. aid this year. Bridge Commrs. have asked for $100,000 and this will aid in constr. of connecting link bet. Ark. and Okla. hwy. systems. Okla. is allotted $8,000,00 and part of this may aid in constr. of Albert Pike Hwy. to the bridge.

Cal., Bakersfield—Decisive steps taken by City Council toward improving main arteries leading into city. Plans and specfs. now being prepared for paving Union Ave.; also for paving Oak St. Proceedings to pave Summer St.—Bakersfield to E. Bakersfield— have been started.

Cal., Long Beach—Ords. for street work adopted by City Comn.: Raymond Ave.—7th to 10th Sts.—grading and constructing 5-in. conc. pavement, cem. curb, walks and gutters; also corrug. iron pipe and cem. culvert; Virginia Ct.—7th to 8th Sts., and La Reina Way bet. Magnolia and Chestnut Aves.—to be graded and paved with conc. base and bit. protective coat; Neptune Pl.—8th to 9th Sts.—to be graded and paved with one-course conc.; alley in blk. 42, resub. of part of Alamitos Beach town site betw. Quito and Redondo Aves. to be graded and paved with one-course conc.

Cal., Visalia—City Trustees have approved plans and specfcs. for paving E. Main St. and widening of Main St. Ests. of cost $425,000, not including paving and proposed viaduct which will cost $500,000 additional.

Del., Wilmington—Street impvts. to cost nearly $900,000 planned for city.

Fla., Jacksonville—Will pave streets here. Voted $100,000 positive and $150,000 tentative bond issues. Jno. S. Bond, Chrmn., City Comn.

Fla., Miami—Commrs. Dade Co. having prelim. surveys and estimates made for bldg 9 miles road from here to Key Largo, asph., brick or macadam. Abt. $100,000. H. Crabtree, Miami, Engr.

Ida., Pocatello—City Comn. has authorized creation of paving Dists. Nos. 25 and 31. Est. cost $624,000.

Ill., Carbondale—Plans being prepared for paving Dist. No. 6 as follows: Elm—Illinois to Poplar; Cherry—Ill. to Hays; College— Poplar to Hays; Mill—Ill. to Rawlings; Ash—College to Elm; Beveridge—College to Elm; Poplar—College to Mill; Rawings—Cherry to Mill; Hays—College to Cherry and Freeman—Rawlings to Forest. Specfs. call for 20 ft. brk. pavement on every street with exception of Cherry and W. College Sts.; a 4-in. conc. base with one in. sand bet. conc. and brick.

Ill., Chicago—$1,000,000 will be spent to repave State St. in downtown district. Under proposed paving plan street level will be made flush with the curb in many places. It is expected to finish the work by July 1st.

Ill., Elgin—Total cost of street paving impvts., outlined by City Council, will be $464,000. Ests. completed by Commr. Morgan H. Brightman and Victor H. Kasser. Of this amt. $35,000 has been allotted to traction company for payment, for pavement bet. and 1 ft. on either side of car trks. Resident streets will be paved with asphalt.

Ind., Indianapolis—Bd. of Wks. confirmed resolution for impvts. of East St., Guilford Ave.—Edgewood Pl. to Maple Rd. Blvd. Plans ordered for perm. impvt. of 1st alley west of Illinois St.—23rd St. to 24th St. Prelim. orders issued for street paving material for improving blvd. place with asph., 1st alley east of Park Ave., with 2-course conc. and Blvd. Pl. Asph., alley east of Park Ave., 2-course conc. De Quincy St.—Mich St. to 10th St., bitum conc.

Ind., Terre Haute—Vigo County had plans prepared for grubbing, grading, paving and bldg. culverts, and small sewers in 2 miles Geo. F. Asbury Rd., Harrison Twp., involving 2040 lin. ft. plain curbing, 10,980 cu. yds. earth excav., 20,300 sq. yds. brikote conc., etc. Abt. $102,368. G. R. Grimes, Co. Bldg. Engr.

Ia., Clinton—Plans and specfs. being prepared by City Engr. for city's big paving program for this year. It is expected to start work early this Spring on following: 6th St., Lyons—Main to old dividing line betw. Clinton & Lyons; 2nd St., Clinton—old dividing line to Reznor St.; 9th Ave.—3rd to 4th Sts.; 10th Ave.—3rd to 4th Sts.; 11th Ave.—4th to 6th Sts.; 4th St.—10th to 11th Aves.; 5th St.—4th to 11th Ave.; 6th St.—4th to 9th and 10th Ave. to Comamche Ave.; 11th—intersect. with 4th St. along diagonal street to intersect. of 10th Ave. and Third St. All will be graded, curbed, paved and resurfaced and from 2nd to 1st street on Second is to to be improved wth curb and gutter.

Ia., Coon Rapids—Town plans to pave, curb, gutter and build storm sewers in about 20 blocks. O. V. Middleton, Mayor. C. L. Huff, Logan, Engr.

Ia., Davenport—City will grade, curb and pave following streets: First St., $30,594; Locust St., $21,383; Middle Rd., $31,685; Spring St., $15,885; Taylor St., $3,426; 10th St., $5,633; Telegraph Rd.,

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.
Barber Asphalt Paving Co.

Hydrants.
Flower Valve Mfg. Co.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.

Kettles (Portable).
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
Lakewood Engineering Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Joint Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Barber Asphalt Paving Co.
Kentucky Rock Asphalt Co.
Sinclair Refining Company.
The Texas Co.

$46,044; Warren St., $7,509; Washington St., $4,937. Material: sheet asph., or Willite pavement on new conc. base. L. W. Christensen, City Clk.

Ia., Fort Dodge—Plans prepared for grading at various locations. Ready for bids about May 1. Engr. L. B. Stephenson, Court House.

Mich., Allegan—City Council has voted to construct over 6 miles of pavement on Water, Ely, and N. Main Sts.

Mich., Jackson—Extensive public impvts. authorized by City Comn. in construction of pavement, sewers and water mains. Work will involve expendt. of approx. $700,000, of which $427,269 will be borne by the taxpayers.

Minn., Worthington—City will pave various streets involving 20,000 cu. yds. grading, 75,000 sq. yds. paving, 48,000 lin. ft. curbing. Cons. Engr., L. P. Wolff, 1000 Guardian Life Bldg., St. Paul.

Miss., Pascagoula—Jackson Co. will constr. conc. hwy. across Beat 4, 17 miles. $180,000 bonds voted. Fred Taylor, Clk. Co. Supvrs. Dist 4.

Mont., Billings—Plans being prepared for paving 4 or 5 miles Burlington, Grand and Alderson Blvds., B. C. D. and E. Aves., N. 32nd St. and portions of 3rd and 4th Aves., N. Abt. $200,000. E. M. Sneckenberger, City Engr.

Mont., Helena—State Hwy. Comn. plans to gravel surf. 11 miles Streater-Exeter Rd., $91,300; 8 miles Dodson-Haro Rd., $60,225; 15 miles Bynum-Dupuyer Rd., $110,000. J. N. Edy, St. Engr.

Mont., Missoula—Dist. Engr. Fred Thieme, Forest Service, announces that Secy. of Agricult. has approved execution of a co-operative agreement for constr. of Cold Springs sect. of W. Gallatin Rd. It is planned to constr. 4 sections of hwy. during coming season, bringing the roard thru the canyon.

N. J., Red Bank—$1,079,000 bonds offered for sale by Freeholders. Of total $667,000 will be known as road bonds and $412,000 as bridge bonds. Clerk has been directed by Freeholders to call for bids for paving Red Bank and Fair Haven road. County Engr. directed to prepare plans for paving Seabright Rd. on eastern end of drawnbrdg. as far as Ocean Ave.

N. Y., Albany—Onondaga Co. Hwys. to be built are as follows: Fayetteville-Mycenae hwy., 3.94 mi.; Scott-Borodino Rd., 4.05 mi., closing gap in loop from Skaneateles to Homer. Other hwys. contemplated are Port Bryon-Conquest, 5.9 miles, Cayuga Co., conc.; Weedsport-Jordan, 3.29 mi., Cayuga Co.; Genoa-No. Lansing, 5.04 mi., Cayuga Co.; Marathon-Cortland, 6.54 mi. and its connect'g hwy. in Broome Co. Lisle-Killowag Rd., 4.37 mi. bitum. macadam; Solon-Gee Brook, 2.23 mi. bitum. macadam, Cortland Co.; Williamstown-Redfield Rd., 9.37 mi. bitum. macad., Phoenix-Mexico, part 3, 2.2 mi. bitum. macadam, Oswego Co.; Watkins-Lodi, 11.43 miles, conc., Seneca Co.

N. Y., Binghamton—Many thousands of dollars are going to be expended the coming season on the "Square Deal Tract." Several thousand ft. of new conc. walk will be laid. It has also been decided to lay curbing in Cook and Lusk Sts. and other short thoroughfares—approximately abt. 10,000 ft. Sewer service will be developed as in the past; tiling will be laid in Floral Ave.—Lusk to Riverside Dr., thence to Theron St., thru Theron onto susquehanna River. The stretch in Theron St.—Lusk to river—covers more than one-quarter of a mile.

N. Y., Brooklyn—Notification received by Boro. Pres. Riegleman that he has been authorized by Bd. of Est. to expend $1,532,500 for paving. Every sect. of Borough will benefit.

N. Y., Brooklyn—Joint local Bds. of Impvt. for Jamaica and Newtown adopted resolutions to grade and pave Rockaway Blvd., from conduit line to New York Ave. and from New York Ave. to Nassau Co. line, all within Jamaica South and Springfield Dists. Est. cost $327,000. Local Bd. adopted petition to regulate, grade, curb and flag Chichester Ave.—Hollis to West Point Aves., Hollis. Some changes must be made to prevent the pocketing of water from W. Point Ave. to Ulster Ave. Proposed impvt. will cost abt. $20,500. Petition to grade, curb, flag and pave Liberty Ave.—Rockaway Blvd. to Lefferts Ave., 4th Ward. (Est. cost $70,000) adopted.

N. Y., Buffalo—Council Comn. in favor of authorizing Commr. Pub. Wks., to go ahead with long delayed asph. paving of streets for which contracts were entered into, work having been delayed to await paving betwen trks. of International Ry. Co. 50 streets are in this category, total cost amounting to about $1,000,000. Company has signified its intention to do its part. It is estimated list of streets, not under contract, proposed to be paved, involves expendt. of abt. $600,000, bringing total cost of paving and repaving up to $1,600,000.

N. C., Asheville—St. Clair Co. will construct Asheville Rd.; voted $56,225 bonds. $225,000 available.

N. C., Asheville—Applications filed for 38,995 ft. of paving here, costing approx. a million dollars. It is expected that work on at least 14,900 will begin this Spring costing betw. $250,000 and $300,000.

O., Kenmore—Plans being prepared for paving streets; also 6 other streets proposed. $284,000 bond issue; has passed Council.

Okla., Norman—72 blocks of paving planned and several miles cement sidewalks. W. R. Gater, City Mgr.

Okla., Okmulgee—Co. Commrs. voted to spend $250,000 to meet fed. aid offer to construct half-million dollar conc. road betw. Okmulgee and Beggs—11 miles.

Okla., Walters—Good Roads Program being promoted by citizens of Cotton County. It will provide hard surfaced roads from Stephens County line on east thru Walters, Randlett and Devol with road no. from 4 miles of Walters to connect with hard surfaced rd. being built from Lawton south. Another proj. is rd. from Walters thru Temple to Byers bridge over Red River.

Pa., Reading—City will expend about $740,000 on various public impvts. These include street paving, sewers, etc.

Tenn., Bolivar—Hardeman Co. plans to pave and construct bridges on 12.9 miles of road from here to McNairy Co. line, 16 ft. wide. $350,000; pave 14.1 mile rd. from here to Fayette Co. line 16 ft. wide, $350,000; both bitum. macadam.

Tex., Brenham—Washington Co. having plans prepared for bldg. 30 mi. East and West Hwy., conc., including conc. draing. structs. and brdg. over Brazos river. Abt. $825,000. Fed. Govt. appropriated $325,000 toward project. G. A. Bracher, Brenham, Engr.

Tex., Corpus Christi—Nueces Co. will construct 34.91 miles of rd. in Precincts 1, 3. 4 of State Hwy. No. 12. $746,813.85.

Va., Lynchburg—City will improve 5th St.—Main to Park Ave. $100,000. E. A. Beck, City Mgr.

Wash., Olympia—State Hwy. Comn. has outlined paving and other work to be done under authorization of new legislation. Program includes 6 miles paving on Sunset Hwy., King Co. It was decided to complete as much as possible this year of Pacific Hwy. This impvt. will involve expendt. of abt. $2,000,000. On Olympia Hwy. Comn. authorized paving from Olympia to Perry Crk., 4½ mi.; 3 mi. from Thurston Co. line to Kamilche; 3½ mi. betw. Aberdeen and Grays Harbor County Club. Grading on hwy. covers widening of route betw. Hoodsport and Brinnon, 10 mi. which work will be commenced shortly; 3 mi. betw. Crocker Lake and Discovery Bay; graveling 11½ mi. around Lake Crescent; grading 7 mi. from Elma to McCleary and widening of hwy. from McCleary to Perry Crk. On National Pk. Hwy. Comn., has authorized 4½ mi. paving—Muck Crk. to Ohop Hill, Pierce County; straightening Ohop Hill grade; 5 mi. paving—Petersons to La Grande; completion of grading in Nisqually Canon; 3 mi. grading La Grande to Alder and 13 mi. grading betw. Alder to Ashford. 3 mi. grading will also be carried from Ashford up toward Rainier Nat'l Pk. gates; 3 mi. graveling will be laid betw. Mineral and Morton. Ocean Beach Hwy. impvt. includes abt. 3 mi. paving and 2 mi. grading—Chehalis to Adna; graveling 8 mi.—Nasel to Bear River, Pacific Co.; graveling 3 mi.—Johnston's landing to Nasel; grading and graveling 5 mi.—Gray's River P. O. to Deep River; constr. of steel brdg. over Cowlitz at Kelos which will cost abt. $250,000. On North Bank Hwy. Comn. authorized excav. government slide in Skamania Co.; conc. brdg. at Stevenson; 10 mi. surfacing on Naches Pass Hwy., from Greenwater River east.

Wash., Seattle—Ord. passed by City to open Olive St.—Bellevue to Broadway, providing wide business thoroughfare from residential distrct of Capitol Hill, Volunteer Pk., Mt. Baker and other districts to downtown bus. section. Abt. $250,000. Cost will be borne by property owners. 98 percent of whom petitioned for impvt. A. Dimock, City Engr.

Wis., Rhinelander—Co. Hwy. Comn. Parker has outlined hwy. work for county as follows: Rhine-

BUYERS' GUIDE

Road Binder.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Company.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Lakewood Engineering Co.
Mayer, F.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
Barber Asphalt Paving Co.
The Barrett Co.
New Orleans Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.

Road Tampers.
Lakewood Engineering Co.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.

Saw Rigs.
C. H. & E. Mfg. Co.

Sandstone.
Cleveland Stone Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnishchfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
Clay Products Association.

Sewer Rods.
Stewart, W. H.

Sidewalks (Stone).
Cleveland Stone Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.

Special Castings.
Crane Co.
Flower Valve Mfg. Co.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Curbing.
Cleveland Stone Co.

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Flagging.
Cleveland Stone Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
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lander-Sugar Cane Rd., Three Lakes Rd.,Monico-Gagen-Three Lakes Rd., Rhinelander-Enterprise Rd. and unfinished Fed. contr. in town of Pelican, Rhinelander-Cassian Rd. Work will consist of regrading, culverts and surfacing with crushed gravel abt. 6 mi. Woodboro-Rhinelander Rd., Trunk Line No. 14; Tripoli-Willo Lake Rd., Squirrel Lake Rd., Woodruff Rd., Woodboro brdg. and large culvert on Trunk Line No. 14.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Ceres—$30,000 bond issue authorized at special election for sewer system here.

Cal., Glendale—$50,000 bond issue carried for sewer system in the Verdugo Woodlands Dist. City will contribute $10,000 for disp. plant. Olmsted & Gillelen, Hollingsworth Bldg., Los Angeles, Engrs.

Cal., Ontario—Resolutions of intention Nos. 460 and 461 for constr. of sewers, adopted by Council. Work will be done under Vrooman Act and will cost abt. $50,000. F. E. Alford, City Engr.

Ont., London—According to City Engr. Brazier $1,000,000 will be expended in City on sewers during 1921. West London sewers will cost $572,000; storm sewers on Wellington St., So., $271,000 and other projected sewers $175,000.

Ct., Bridgeport—City plans constr. of storm and san. sewers in several streets. J. A. McElroy, City Engr. Sewerage and Paving Comn. plan to complete san. lateral sewerage sys. in Black Rock Sec., $50,000; build san. sewerage sys. in Mountain Grove Street et al., $60,000; storm water and san. sewerage sys. in Grand St., $65,000; Park St., $15,000, Lindley St., $75,000. J. A. McElroy, City Engr.

D. C., Washington—Will issue $375,000 bonds for constr. and acquiring sewer and water systems within Wash. Suburban San. Dist.,—area comprising 90 sq. mi. surounding Dist. Wash. Suburban San. Comn. Wm. T. S. Curtis.

Ill., Roodhouse—As now planned the new proposed sewer system will cost $116,000.

Ill., W. Chicago—Plans and cost of storm water sewers to drain W. Chicago in part and whole, show cost to be $177,000 to drain main streets and $311,000 to constr. complete system.

Ind., Evansville—Mayor Bosse announced he had requested City Engr. Jas. D. Saunders to prepare plans and specfs. for what is probably largest sewer impvt. program ever undertaken in City. First and larger sewer will be 4 mi. in length, exclusive of lateral inlets and will require more than a year for constr. It will be 8 or 10 ft. in diam. at mouth. Mayor hopes to let contr. abt. middle of Summer; second sewer will be a main sewer to drain northern sect. of city.

La., Cedar Grove—Prelim. plans and surveys made for constr. of sewerage system to include disp. plant. Abt. $125,000. E. T. Archer & Co., Kans. City, Mo., Engrs.

Mass., W. Springfield (Springfield, P. O.)—City plans to constr. sewerage system in Meadows Dist. Abt. $35,000. Private plans.

N. Y., Utica—City Engr. Cookingham authorized to call for bids for constr. of san. sewer in E. Utica, and Oneida St. and Baker Ave. sewers. Approx. cost $65,000.

O., Bowling Green—State Board and Commr. has ruled that city must make immediate plans for erection of disp. plant. Engineer will have to be employed and matter of bonds placed before the people. This will probably be in August.

Pa., Philadelphia—Haverford Township plans to install $500,000 sewer system.

S. D., Springfield—At special election bonds of $32,000 carried for installing sewerage system here.

Tenn., Johnson City—$150,000 bonds voted for street and sewer work. W. C. Dyer, Commr. Sts. and Engr.

Tex., El Paso—City considering improving disp. plant. Initial cost $120,000.

Tex., Houston—City considering constr. of sewers in Montrose Yoakum Blvd. $50,000.

Wis., Milwaukee—It will cost Whitefish Bay $55,462 to constr. intercepting sewer to connect with Milwaukee's sewerage system, according to ests. filed with State Bd. of Health. E. G. Orbert, Vil. Engr. Ests. also submitted by village of Shorewood.

Wis., Jefferson—Contemplate installing sewers on Plymouth St., to proposed new bldg. of efferson Realty Co. Abt. 2,800 ft. Engr. Parsons and Orbert, 216 W. Water St., Milwaukee. Robt. K. Henry, City Clk.

WATER SUPPLY AND PURIFICATION.

Que., Montreal—Water Board plans to do following work this year: Build addns. to filtr. plant, cost $500,000; constr. low-level reservoir, $2,000,000; addn. to Peel Street reservoir, $375,000; pumping station and equipt. for Notre Dame de Grace Ward, $500,000; addition and exten. to water intake at Lasalle brdg., $200,000; raising mains to Peel St. reservoir, $85,000; new force main from low level pumping station to east end, $2,375,500; additional main from McTavish reservoir to Papineau Ave., $840,000; reinforcing present mains to Notre Dame de Grace Ward, $222,500; additional mains to feed Ville Emard ward, $332,500.

Conn., Kensington—Fire Dist. plans to extend water supply systems. Est. cost $100,000. Engineer not selected.

D. C., Washington—$375,000 bonds will be issued to construct and acquire water and sewer systems with Wash. Suburban San. Dist., an area comprising 90 sq. miles surrounding dist. Wash. Suburban San.

Fla., Jacksonville—Contemplate constr. of water works; $100,000 voted (positive) and $100,000 (tentative) bond issues. Jno. S. Bond, Chrmn. City Comn.

Ga., Atlanta—$2,850,000 water works impvt. bonds voted here.

Ill., Bloomington—In accord. with plans reached at executive session of City Council, Dept. of Parks & Pub. Prop., is going ahead with plans for development of new West Market St. water plant. Present plans call for connect. of west side plant with city system by means of a 10-in. main direct from reservoir to Morris Ave.; sinking of one addn. well at west side plant and installation of suitable pressure pump to replace one now in use. Two pumps for west side plant ordered.

Ind. Indianapolis—Prelim. plans complete for erection of a 10,000,000-gal. reservoir at Riverside pumping station of Indianapolis Water Co. Total cost of reservoir will be approx. $285,000; excav. betw. $30,000 and $35,000.

La., Cedar Grove—Prelim. plans prepared for constr. of new water wks. systems; will either drill well for supply, or get supply from Shreveport. Abt. $125,000. E. T. Archer & Co. Kans. City, Mo., Engrs.

Mich., Manistique—Ready for bids abt. May 1st for pumping station. Engrs. Alvord & Burdick, 8 S. Dearborn St., Chicago, Ill. 1 sty., 80x90 rein. conc., brk., $75,000.

N. Y., New York—Queens Boro. residents (Ridgewood, Glendale and Evergreen Dists.) have demanded that water mains be extended. Est. cost, $1,400,000.

O., Fremont—Geo. H. Clark, Engr., Toledo, will revise plans for proposed purification and water softening plant to be erected by county at $200,000.

O., Lakeview—Plans being prepared for pumping station and 3 mi. 6-in. mains. Abt. $70,000. H. Gilgore, Clk. Jennings-Lawrence Co., Hartman Bldg., Columbus, Engrs.

O., Youngstown—City will soon receive bids for laying water mains and installing addn. pumps at main water plant. Abt. $650,000. G. F. Turner, City Hall, Engr.

S. D., Sioux Falls—Ready for bids abt. April 25 for addition to water wks. bldg. Geo. W. Burnside, Mayor. Archt. Jos. Swartz, 404 Minnehaha Bldg. Sioux Falls, will take bids; 1 sty. and basement, 70x90 struct. steel, r. c. frpf. stm. htg. conc. slab flr., Bedford trim hol. tile, rf. vents, skylights, steel sash, brk., steel truss and tile rf., $85,000.

Tex., Dallas—David Morey, Jr., Dallas, retained by City as designing and supervising engineer for $450,000 filtr. plant at White Rock reservoir. Plans will be started immediately and it is hoped actual constr. can start within 3 mos.

Va., Norfolk—City considering addn. impvts. to water works; complete constr. of Lake Prince Reservoir; dam at eastern end, pipe line, pumping station and bridges. $4,000,000. C. E. Ashburner, Mgr. Walter H. Taylor 3d, Direct. Pub. Wks. Dabney H. Maury, Cons. Engr.

W. Va., St. Albans—St. Albans Light, Water & Ice Co., Myron G. Campbell, will extend water wks. and constr. 1,500,000-gal. filtr. plant. Total cost $75,000. H. K. Bell, Engr., Lexington, Ky.

Wis., Kawaskum—Plans drawn for water and sewer mains, wells and pump. Jerry Donohue, Sheboygan, Engr. Ed. Mueller, City Clk. $90,000.

INDEX TO ADVERTISEMENTS

Acme Motor Truck Co., Cadillac, Mich.....
Alvord, John W. & Charles B. Burdick, Chicago, Ill. 173
American Cast Iron Pipe Co., Birmingham, Ala. 171
American Steel & Wire Co., Chicago, Ill..... 8
American Telephone & Telegraph Co., New York, N. Y. .....
Artingstall, Wm., Chicago, Ill..... 173
Austin-Western Road Machinery Co., Chicago, Ill. 4
Austin Machinery Corporation, Chicago, Ill.

Badger Crushed Granite Co., Chicago, Ill...
Barber, Asphalt Paving Co., Philadelphia, Pa. .....
Barrett Co., The, New York, N. Y..... 155
Brown Portable Conveying Machinery Co., Chicago, Ill. .....Inside Front Cover
Bitoslag Paving Co., New York, N. Y.....
Brossman, Chas., Indianapolis, Ind..... 173
Burch Plow Works Co., Crestline, Ohio.... 31
Burd & Giffels, Grand Rapids, Mich..... 173
Buyers' Guide 40, 42, 44

Cannelton Sewer Pipe Co., Cannelton, Ind... 10
C. H. & E. Manufacturing Co., Milwaukee, Wis. .....
Chicago Paving Laboratory, Chicago, Ill... 173
City Wastes Disposal Co., New York, N. Y.. 173
Cleveland Stone Co., The, Cleveland, Ohio.. 10
Coldwell-Wilcox Co., Newburgh, N. Y..... 174
Cummer & Son Co., The F. D., Cleveland, Ohio 8

Dee Clay Mfg. Co., W. E., Chicago, Ill..... 31
Dee, Wm. E., Chicago, Ill..... 10
De Laval Steam Turbine Co., Trenton, N. J.
Direct Oxidation Process Corp., Philadelphia, Pa. 174
Dow & Smith, New York, N. Y..... 173
Duplex Truck Co., Lansing, Mich.....
DuPont DeNemours & Co., E. I., Wilmington, Del. .....

Engineers and Contractors.....173, 174

Fargo Engineering Co., Jackson, Mich..... 173
Flood, Walter H., Chicago, Ill..... 173

Gannet, Seelye & Fleming, Harrisburg, Pa. 167
Garford Motor Truck Co., Lima, Ohio.....
Good Roads Machinery Co., Inc., Philadelphia, Pa. .....
Granite Paving Block Mfrs. Assn. of the U. S., Inc., Boston, Mass..... 6

Heim, Carl, Chicago, Ill..... 6
Heltzel Steel Form & Iron Co., Warren, Ohio 5
Hill & Ferguson, New York, N. Y..... 173
Holt Mfg. Co., Inc., The, Peoria, Ill..... 9
Howard, J. W., New York, N. Y..... 173
Hunt, Robert W. & Co., Chicago, Ill..... 173

Jones, Sam L., Cincinnati, Ohio..... 173
Jordan & Steele Mfg. Co., Inc., Charlotte, Mich. 31

Kalamazoo Foundry and Machine Co., Kalamazoo, Mich. 174
Kentucky Rock Asphalt Co., Louisville, Ky. 2
Kirchoffer, W. G., Madison, Wis..... 173
Kissel Motor Car Co., Hartford, Wis.....14, 15
Koehring Machine Co., Milwaukee, Wis..... 25
Kolesch & Co., New York, S. Y..... 37

Lewis-Hall Motors Corp., Detroit, Mich....
Littleford Bros., Cincinnati, Ohio..... 6
Lufkin Rule Co., The, Saginaw, Mich..... 8

Macnaughton, David, Ft. Wayne, Ind..... 174
Madison Foundry Co., Cleveland, Ohio..... 174
Mayer, F., Chicago, Ill.....
Medal Paving Brick Co., Cleveland, Ohio.. 10
Metropolitan Paving Brick Co., Canton, O.
Midwest Engine Co., Indianapolis, Ind..... 29
Motor Truck Section.....11, 22
Mueller Mfg. Co., H., Decatur, Ill..... 165
Murphysboro Paving Brick Co., Murphysboro, Ill. 10

National Paving Brick Mfrs. Assn., Cleveland, Ohio .....
Newport Culvert Co., Inc., The, Newport, Ky. .....
New Orleans Refining Co., New Orleans, La. 10

Olsen Testing Machine Co., Philadelphia, Pa. 10

Packard Motor Car Co., Detroit, Mich..... 13
Pawling & Harnischfeger Co., Milwaukee, Wis. 27
Pennsylvania Salt Mfg. Co., Philadelphia, Pa. 174
Pierce-Arrow Motor Car Co., Buffalo, N. Y. 17
Pioneer Asphalt Co., Lawrenceville, Ill..... 6
Portable Machinery Co., Inc., Passaic, N. J.
Portland Cement Association, Chicago, Ill. 22
Potter, Alexander, New York, N. Y..... 174

Republic Cresoting Co., Indianapolis, Ind... 10
Rosing Inc., Astrid S., Chicago, Ill..... 174

Sauerman Bros., Chicago, Ill..... 29
Shields, W. S., Chicago, Ill..... 174
Smith Co., The, T. L. Milwaukee, Wis... .....Back Cover
Springfield Paving Brick Co., Springfield, Ill. 8
Standard Oil Co. (Indiana), Chicago, Ill.... .....Inside back cover
Stensrud, Herman, Marquette, Mich..... 174
Stewart, W. H., St. Louis, Mo..... 171
Strickler, W. W. & Bros., Columbus, Ohio.. 171
Sullivan, Long & Hagerty, Bessemer, Ala... 174

Texas Co., Asphalt Sales Dept., New York, N. Y. 7
Truscon Steel Co., Youngstown, Ohio..... 4

United States Cast Iron Pipe & Foundry Co., Burlington, S. J..... 171
Uvalde Asphalt Paving Co., New York, N. Y. 10
Van Trump, Isaac, Chicago, Ill..... 174

Warren Brothers Co., Boston, Mass..... 1
Webster Mfg. Co., The, Chicago, Ill..... 169
Wells, James P., Rochester, N. Y..... 174

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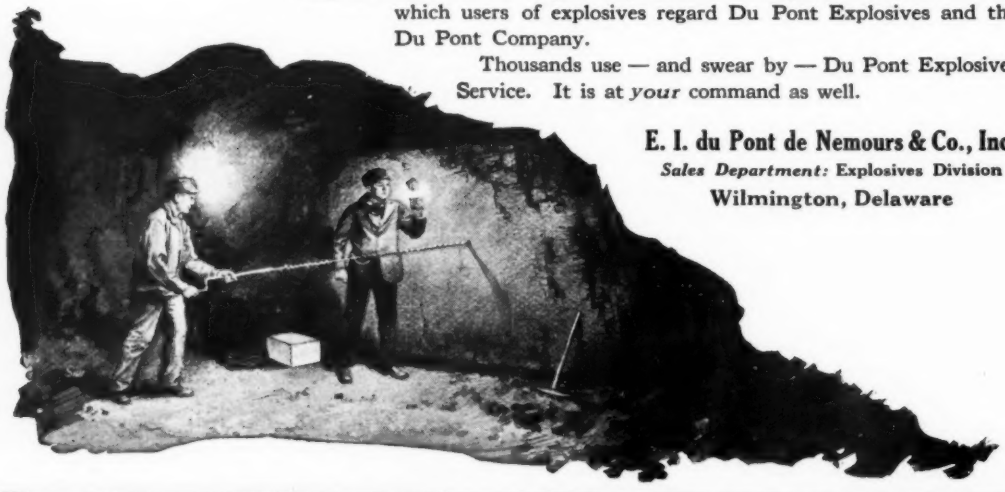

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